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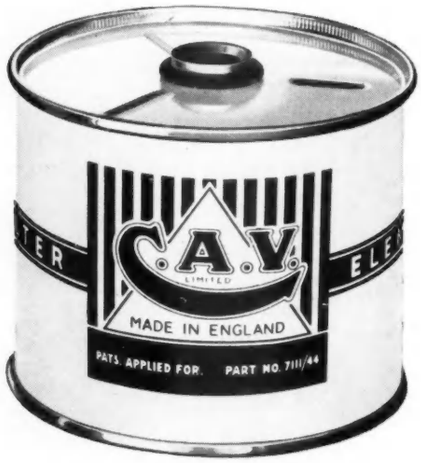

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ENGINEERING

PUBLISHED EVERY FRIDAY

Vol. 188 No. 4877 9 October 1959

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Autumn Flower

SOMEWHERE along the line of the new Government's programme we shall see, if we may recall the campaign for a moment, the blossoming forth of a bright new political flower, the Minister of Science. Since there is hardly a Government department in which science is not important, the new Minister may become so powerful that the whole balance of cabinet government will alter. Or it may be a change in name only, a sop to a public for whom the word scientific banishes doubt, an implied promise that one fine day we too shall have a rocket on the moon.

The facts are simple enough. It is not proposed that a great battle be joined with the Ministry of Supply and the three Services so that their research and development can be transferred into fresh hands. Coodinating the work of the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council and the Nature Conservancy would mean in financial terms that the minister would be presiding over rather more than one per cent of the budget: in 1959-60 figures £55 millions out of a total estimated expenditure of £5,223 millions. Add in the atomic energy programme and space research and the proportion becomes significantly greater, even if the minister's mental process grows confused in proportion.

But there are hidden reefs here and they need to be carefully noted. The idea of science being spoken for at the highest level, by a well loved and trusted statesman of the ruling party, may seem an overdue blessing. If that is what is intended then something quite different, almost a Ministry of Engineering, would have been enough. Experience does not suggest that things will go that way at all. Rare indeed is the politician who does not at some stage on the ladder think himself ideally placed to complete the course to the very top rung. The temptation to see the job as a staging post to No. 10 would be very strong indeed. And how to use it if not to get results? This year a fleet of hovercraft, next year the world's first underwater floating dock for atomic submarine cargo carriers. As a nation, could we afford the diversion of manpower and money and as a politician could the minister afford not to try his hand?

As a step in the adaptation of democratic government such a new minister would follow the habit of gradual growth. The first Government committee on spending for science sat in 1915; the DSIR was born; the Lord President of the Council has presided, but the Prime Minister has been keeping an eye on atoms. Now all this is to pass to a properly named senior minister. Education moved in a similar way, reaching a Board of Education and finally being dignified with its own ministry. If the education post has remained a political poor relation, that for science cannot be expected to do so. The very prospect of its stature makes the identity of its holder of first importance.

The House of Commons has chamber after chamber of barristers, no shortage of company directors or schoolmasters. But it is not naturally an attractive place to a scientist trained to the discipline of observation and mathematics rather than the discipline of party whips and expediency. Perhaps a life peerage for a man qualified to understand and suitably recognised is one answer. It would carry the scientist's representative to the cabinet, but not the House most fully reported.

Sooner or later the minister will have to be given some staff. And here Parkinson's First Law applies. Work expands so as to fill the time available for its completion, wrote the professor. Once the public relations men had been let loose on explaining science to the public, particularly the voter, the committees on progress in this and that, and the directors and deputies and assistants had dug themselves in, the time scientists spent working in laboratories could become as little as the peace-time soldier spends on maneouvres. The Admiralty, as Parkinson pointed out, or at least the shore-going Navy, has swelled and swelled as the size of the Fleet has diminished. The Colonial Office has flourished and multiplied as the colonial territories have come to self-government and set up on their own. Science as a strong and growing force could become the base for a ministry of awesome size.

Would it do any good? The essential factor in scientific research in Britain lies in the universities, and undeniably to some extent in the laboratories of the United Kingdom Atomic Energy Authority. The UKAEA must in present conditions be a Government concern, which is all the more reason why the universities should be rigorously secluded from involvement with a science minister. But coordination, to give full value, could embrace a wider field than suggested by both political parties. Much of the research of this country is carried on in the laboratories of its industries. If the new minister would concentrate on improving the channels of information in industry, and between industry and the bodies he will inherit, he would be making the most effective single contribution open to him.

Cover Picture.—*Cold bending a 2 in thick mild steel plate on a 3,300 ton press. The plate was grooved before bending and will form a half-section of a colliery winding drum. The operator is shown checking the curvature.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

I recently read a novel about the Secret Service, in which the hero belonged to an undercover unit called D_2d, known disrespectfully as "dust-to-dust." Among the curious duties of this detachment was the responsibility to ensure that no malefactor upset the balance of nature within the British Isles. Presumably a man from D_2d stood in the shadows of the customs shed watching for any hood-eyed immigrant who might conceal beneath the lapels of his overcoat a rabbit, grey squirrel or Colorado beetle. Little did they know that a virulent fifth column already existed. In my view, not atom bombs or insects, but industrial effluents and gases represent the greatest danger to our environment. They may even influence the weather, or so I'm told.

This summer provided a foretaste of future life in Britain, according to the signs. Tropical skies seem a remote prospect in a country noted for climatic gloom, but there are responsible scientists who believe that the prodigious quantities of carbon dioxide exhaled yearly into the atmosphere will change its thermal properties in such a way that the average surface temperature of the earth will be raised by several degrees. This, unfortunately, will make the tropics uninhabitable and England somewhat overcrowded, but there will be compensations. People might even start talking to each other in trains, and adopt such alien Mediterranean habits as spicy cooking and shaking hands. Reserve and phlegm will disappear and the fox-trot will give way to saraband.

Something similar has already happened in the Thames, which recently has undergone a change of character: the old pace but a new rhythm. It is said that heat rejection into the river has raised its temperature, creating flora and fauna of an unfamiliar character, exotic species typical of the waters in subtropical lands. Though not a fisherman myself, I sympathise with the angler who asks his wife to gut a guppy—and conversely with the power station operator, who is already finding his cooling water sources inconveniently warm.

In one sense this summer has been misleading: the future won't be dry. In fact the climate will be humid, what with the increased rate of sea evaporation and perspiring humanity. The polar ice caps will also melt and raise the level of the oceans. The way ahead appears to be retrogressive, back to where we started in primaeval ooze.

It is true that we have been upsetting the balance of nature ever since man first made a spear. But now that we are disturbing it in a big way, we had better take care. Perhaps we've reached the threshold of cumulative effects.

CAPRICORN

Weekly Survey

A Thrust Near the Heart

Take away a man's oxygen and he dies. Deprive industry of its oxygen and within a matter of working hours men are being stood off in the car plants and shipbuilding and steelmaking itself are threatened.

The particular structure of the British oxygen industry, in which one firm supplies very much the greater part of the nation's industrial oxygen, and where the steelmakers are almost alone in being independent of a very short pipeline indeed, means that any upset has dramatic results. The strike of the British Oxygen men has been almost sinister in being so disruptive in effect and yet almost without any possible gain for the strikers.

Almost because, while the strike is unlikely to have put back the date, 21 September, which the union and the company had already accepted for back dating any agreed rise, it is apparently felt among some of the men that a display of "wildness" may well be taken into account next time the firm and the company are negotiating. Yet this is unfortunate in that British Oxygen's relations with the Transport and General Worker's Union and the others in the negotiating machinery are known to be good and wage settlements have been made with reasonable promptness in the past—as this one showed every sign of being.

The coincidence of a brief stoppage before the 1955 general election seems to have been no more than a coincidence. But the ugly fact remains that 1,700 men suddenly, and without much idea why, threw at least 60,000 of their fellow workers into idleness.

Whether or not such a display affected the general election one way or another is probably impossible to establish. What it did demonstrate is that union relations with rank and file have here reached a point where the maximum unemployment per striker could be caused at perhaps the worst political moment for the Labour movement as an entity.

Can Coal Make a Come-Back?

The National Coal Board's winter campaign to keep industrialists from succumbing to the blandishments of the oil merchants is opening up with a judicious bombardment of advertising. Looking behind the posters produces an uneasy feeling that once the initial barrage has had its effect some of the vital troops will be found not struggling with the enemy but hard at work in the training camps. For the Board, even as the benefits of coal to manufacturers is being explained, is holding the interviews for the fifty "skilled salesmen" backed up by thirty new fuel technicians, whose jobs have been created by the recognition that an improved technical and general sales service is essential. Those who are new to the industry are to receive thorough training in its techniques.

But methods apart, there are indications that the tide is not flowing so strongly against Hobart House as it has been. Two and a half million tons of coal in the industrial field were displaced by oil in 1958 and the rate at which conversions to oil are leaving coal on the board's dumps is now down to 900,000 tons a year. Somewhere among the factors leading to this result is the ending of the two-year disadvantage the coal industry suffered under the Clean Air Act.

But there is no disposition at the Coal Board to underestimate what is at stake. Mr. R. H. E. Thomas, marketing member of the Board, has assessed that the annual coal consumption of industrialists who are considering going over to oil is 2¼ million tons. It needs no sentiment, but only reflection that coal needs neither foreign concessions nor transport from foreign parts and that the purchasing power of its 700,000 people is highly significant, to hope that the Board's efforts to meet the needs of industry are successful.

Detailed help in finding exactly the type of coal to give the best return, expert sales advice in having the coal delivered by the cheapest route, these will help. But price is the headline hitting factor, the more so with coal which is publicly owned than oil which is not, and here the Board are able to point to stability since July, 1957, and to falling production costs, at a time when some dissatisfaction with the return obtained on fuel oil has been heard from elsewhere.

Gas Without Coal

With what sounded like an air of grim satisfaction, Sir Harold Smith, the retiring chairman of the Gas Council has referred to the growing independence of the gas industry from coal supplies. The National Union of Mine Workers had already accused the gas industry of blackmailing the Coal Board to get lower prices. Sir Harold bluntly retorted that the gas industry succeeded in breaking the coal industry's monopoly by developing other sources for gas. The fact is that whatever silly words may be used in criticism, the gas industry has been encouraged to develop new sources because of high coal prices.

Sir Harold said that for a number of years coal would be the main fuel for the gas industry. Poorer coals would be used than in the past however, and this would react on the supply of coke. The industry was at present using about 24 million tons of coal a year. This would be reduced to 21·5 million tons by 1964-65. The importation of liquid methane was not taken for granted but was not yet economic to use. He added rather pointedly that the Trade Unions of the gas industry were backing the Council's policy.

No Electric Shocks

For the coal industry the most significant part of the first Annual Report and Accounts of the Electricity Council is that of the net output capacity planned for the end of 1964—33,600 MW—about nine-tenths will come from conventional, mostly coal-burning plant, and only about a tenth from nuclear stations.

The overall picture of the electricity supply industry is of rather more customers all using rather more current. The figure for England and Wales is of 15,182,772 consumers at the end of the year (31 March, 1959), 2·1 per cent more than the previous year. The sale of electricity to all users was 7·5 per cent up; industry increasing its use by 3·7 per cent, commercial users by 8·5 per cent and domestic customers 12·8 per cent. Partly because of the steady price of coal the average cost of a unit was 1·554*d*, only a fractional increase on the 1·533*d* of the year before.

The Council is able to claim that with new and better capital equipment, improved organisation and operations on a larger scale have enabled the price of electricity to be held to only 36 per cent above the average 1947-48 unit price. Compared with general retail price movements over the same period electricity has become about 17 per cent cheaper.

This sort of price performance, plus the housewife's growing preference for not only cooking, but water heating, space heating and washing the family's clothes at the flick of a switch, firmly indicates a future of rising demand for

electrical power. On the land there is still one farm in four without power, and still a tendency for farmers to confi ne their use of it to domestic purposes. The target is to raise the number of electrified farms to 85 per cent by 1963.

Seeking to work at maximum efficiency the Council naturally dislikes short bursts of peak demand. It has, a little sadly, to report that at present the trend is towards shorter working hours. A reversal of the downward trend in the load factor may come from increasing use of automatic processes in industry and, of course, from the bounding production performance of industry which has become apparent since the end of the period described by the Council.

Not so New Towns

From Crawley in Sussex to Glenrothes in Fifeshire, the fifteen new towns spread their lawns and gardens, constantly visited by admirers from abroad, lively evidence of this country's ability, for all her mature years, to create anew. From the grimy, overcrowded centres of the big industrial cities to the gentle, wooded prospects of Hatfield or Bracknell must be, for all the families that have made it, very like what Blake would have seen as a move from Satanic mills to the New Jerusalem. Yet there is a sense in which perhaps it has been just a little too easy for the Development Corporations.

After all, if you have a certain number of houses and the idea is to keep the density down, what is simpler than tacking on to each a few more feet of garden. Very nice for the statistics but not much good in the little house at one end of the garden when it is raining outside, Mum wants to use the sewing machine, Dad has the TV turned well up, Cyril is trying to do his homework on the corner of the table, and at any minute Cynthia will be bringing her latest "steady" home.

Walking round the new towns, or about the skillfully mounted New Town Exhibition arranged by the Town and Country Planning Association and the Development Corporations at the Royal Academy, Piccadilly, one of the clear impressions gained is of the smallness of the houses. It is highly relevant here that the Association, in its evidence to the Central Housing Advisory Committee's sub-committee on housing standards, should have firmly held that in every home in which four or more people are to live there should be two living rooms. Equally they believe that every member of the family more than ten years old should have his own bedroom—and a room of not less than 100 sq. ft at that.

In the areas from which many of those now living in new towns came, it was a characteristic of the way of life that absence of separate space for adolescents to entertain their contemporaries at home drove them out onto the streets; lack of a quiet, shut-off area for study damaged school careers; and, for the parents themselves, the effects of high noise level and the difficulty of never being alone in the house were obvious enough.

For all the specious talk about open-plan homes, if the many small homes of the new towns are merely reproducing these conditions in more airy surroundings then, after the gigantic task of remaking the older centres, there may lie that of rebuilding the new towns.

Hollow Boom

When allowance is made for the holidays, industrial output in August was the highest ever recorded. The official index of industrial production provisionally estimates the level at between 113 and 114 (seasonally adjusted) compared with 112 in July and 105 in August, 1958. Since the beginning of the year the index has risen by between 6 and 7 per cent and this is more than the expected increase for the whole year as it was foreseen about Budget time. The recovery has begun to stimulate some sections of the light engineering industry and the steel industry is now on its way to recovery.

In contrast the latest machine tool orders are disappointing and behind these figures lies the continuing sluggish performance in some sections of the steel industry and many sections of the heavy engineering industry. There is a reluctance on the part of industry to order new equipment on a big scale. The public ulilities and the service industries have been big buyers of machinery over the last 12 months but if orders from them should slacken off the engineering industry could find its recovery postponed well into 1960. High productivity from existing plant, a margin of unused capacity and pre-election caution must have covered businessmen to take something less than an optimistic outlook in many industries which are key customers of engineering concerns.

Widening Rift?

By the end of this month the drafting of the detailed proposals in Stockholm for the Free Trade Association is due to be completed and the indications are that the deadline will be met. At the end of the year, which is only three months away, the second round of increased quotas is due to come into operation in the European Economic Community. The time is, therefore, rapidly approaching when a more concerted effort will have to be made to find a *modus vivendi* between the FTA and the Community.

As autumn draws on there are signs of increasing anxiety that it may not be easy to prevent two economic blocs developing in Western Europe with mutual antagonism. The president of the Federation of British Industries, Mr. W. H. McFadzean, spoke on this theme to the Purchasing Officers' Association at its annual conference. He said that British industry was concerned lest any such split in Western Europe should take place. The Dutch government indicated recently that it is not prepared to sacrifice its membership of the Common Market in exchange for a more nebulous form of cooperation with other countries. At one time the Dutch were favourably disposed, along with West Germany, towards the FTA. Time is showing, however, that the European Economic Community is working and is probably working more rapidly than even the optimists had hoped. Under such circumstances, the members of the Community are not likely to be increasingly accommodating in any bargaining which may take place with the Stockholm group in the coming months.

Rocketing Ahead

When Lunik III, the Russian "interplanetary station" was successfully launched on 4 October, the Tass news agency announced that a radio link would be used to "control the elements of the orbit of the interplanetary station" as it circled the moon on its way back to earth. There seems no reason to doubt this, and it is a remarkable piece of engineering. At the same time Tass also announced that there was no doubt constant radio communication would soon be established between the moon and the earth, an even more remarkable feat, but one which the Russians may well rapidly carry out with their apparent mastery of rocket engineering.

When the Atlas-Able moon rocket blew up at Cape Canaveral on 24 September, it must surely have taken with it any doubts that may have remained as to who is ahead in the highly important space race. Not only are the Russians well ahead but they are undoubtedly progressing at a faster rate. As an eminent American professor recently put it on his return from the USSR, the United States could catch up with Russian space technology in three years—but only if the Russians were to stop work in the meantime.

Letters to the Editor

FIRE LOSSES

SIR, The importance of export trade to this country and its influence on the preservation of a sound economy is a matter of the utmost concern.

Of paramount importance since the war has been the growth of exports from the motor industry where close attention to technical developments and the use of masses of machine tools are now being reinforced by the introduction of automation. The high cost of capital equipment for such methods of manufacture has placed in the foreground the gravity of large-scale losses by fire wastage.

To the following brief list of post-war fires at engineering premises must now be added that at Rootes' works at Ryton-on-Dunsmore on 22 September, 1959, estimated at £3 million, and that at the A. V. Roe factory at Chadderton, on 3 October, for which Sir Roy Dobson has put the damage at between £1 million and £2 million:—

Electrical Mfs, South Wales	1950	£1 million
General Motors, USA ..	1953	£20 million
Kelvinator Refrigerator ..	1956	£1,400,000
Jaguar Motors, Coventry ..	1957	£2,250,000
Goodyear Tyre Company ..	1957	£1 million
Rolls-Royce	1959	£1 million

In October, 1958, Morris Motors, Cowley, put into production the largest paint shop in Europe, housed under one roof, at a cost of £3 million.

It is clear from the foregoing that where large quantities of expensive machinery and plant are housed under one roof, proper methods of fire control must be instituted without delay. Without this, large units in the motor and other industries must face a continuation of the risk of sudden disaster and grave dislocation of output. What is of far greater importance, however, is that private enterprise must *in the first place* make a mental re-adjustment towards the problem of fire control. This country is not keeping in step with the progress of its competitors abroad—there must be no let up, hindrance or wastage in the national effort. Is the attitude to be one of complacent mediocrity under the protection of fire and loss of profits insurance?

Yours faithfully,

R. C. SMART.

Shaftesbury Buildings,
61 Station Street, Birmingham 5.
29 September, 1959.

DESIGNING FOR INDUSTRY

SIR, Capricorn's Plain Words in your issue of 25 September were such a subtle blend of principle and prejudice that I feel bound to reply to some of his half-truths about the Council of Industrial Design. For instance, he says that "the Government contribute most of the £300,000 a year they (the C.o.I.D.) live on"; that is, of course, strictly accurate but does it really reflect the true position: £180,000 Government grant; £120,000 earned income? He says there are no engineers among the 25 members of the Council, but he does not point out that chairmen and directors of firms that are very closely concerned with engineering—such as GEC, Rolls-Royce, British Aluminium, Morphy Richards, Henry Hope and Sons, Allied Ironfounders, etc.—are still, or recently have been, members of the Council. He dismisses two of the Council's outside advisers who were particularly chosen for their concern for engineering as "industrial artists"—surely as pejorative a phrase in this context as his "paragons of appearance" a few lines lower down to describe the goods selected for showing in the Design Centre. Nor does he mention that the majority of products accepted for Design Index—and particularly those of a mechanical nature—are subject to examination by technical advisers specially nominated by the industries themselves, who may veto an item on technical or functional grounds however much a selection committee may like its appearance.

He then refers to the C.o.I.D. as "Government-appointed arbiters of appearance design" but

omits to mention that the C.o.I.D. is neither armed with, nor wishes for, any sanctions in its work; it is purely an educational or persuasive body doing as much as it can within its means to encourage an interest in better standards of design. The Council would deplore as much as Capricorn would any tendency towards official orthodoxies of taste. But if Capricorn is satisfied with things as they are, if he really feels no need for improvement in the design of things around him, I can understand his antaongism towards any institution or council whose job is to attempt an improvement. I can, however, assure him that the C.o.I.D.'s day-to-day contacts with manufacturers, designers, shopkeepers and the public will prevent its becoming "a remote Design Academy." If there were danger of that the Council itself would be the first to protest.

Yours faithfully,
PAUL REILLY,
Deputy Director.

The Council of Industrial Design,
28 Haymarket, London, SW1.
29 September, 1959.

ECONOMICS OF TRANSPORT

From Brig.-General Sir H. Osborne Mance, K.B.E.

SIR, In his paper on "Economics of Transport" read before the British Association and reported on page 223 of your issue of 18 September ("Railways, Roads and the Public Good"), Sir Reginald Wilson touches on numerous points on which a Government decision is necessary before making a start on the overdue reconsideration of our national transport policy.

Possibly the most important new feature is the emphasis on track costs. In the full text of his paper, Sir Reginald has made a great step forward towards recommending the pooling of track costs of the different forms of transport under a Track Authority. The underlying argument in Sir Reginald's paper in favour of pooling track costs can be illustrated by supposing that the whole of the transport of the country, including the private carrier of his own goods, were an absolute monopoly under an omniscient dictator, responsible for the upkeep of all forms of track and for the operation of all forms of transport, including the fixing of tariffs. The dictator would find he was saddled with the track cost of all means of transport, which at any moment constituted a fixed item of his transport budget. It follows that the cheapest cost of conveyance in each case would depend on the lowest operating cost independent of the form of track used. The simplest way of basing charges on operating cost would be to pool track costs and to levy a uniform track toll per ton-mile or passenger-mile of traffic.

Sir Reginald lists the kind of items which comprise the social policy of the Government as it affects transport, and which are the cause of non-paying services which the railways and public road passenger services are called upon to perform. If public transport is to function on a commercial basis it must be paid on a commercial basis for such non-paying services as it is obliged to perform. A vital decision is required as to whether these payments should be met by the taxpayer or by the users of transport generally.

Sir Reginald points to the serious threat to public transport from the C-licence operators who use public services only as a standby when private transport is expensive or impracticable. It would evidently be against the social interest to try and safeguard the public services by the regimentation of traffic. Freedom of choice of the means of transport is surely essential for the best social and economic development of the country. The remedy would seem to lie in ensuring that every user bears the full cost of the transport he enjoys. This implies that the private haulier, including also the private car, should make an appropriate contribution for the availability of public transport. The assessment of this contribution requires further study.

Sir Reginald touches on the "legacy of the past," an important aspect of road finance and, therefore, of any comprehensive transport policy. If the Government were forming a commercial corporation to organise the track of all forms of transport, they might well have contemplated including in the capital structure of the corporation the value of the "legacy of the past." The basis of such valuation, however, would not be the original capital cost, still less the cost of replacement of the road assets at the present time, but the capitalised value of the expected earnings of the assets, as also would be the case with the railway track. Since the cost of road assets representing the "legacy of the past" has been amortised the Government can afford not to levy a charge for interest, and with pooling track costs it will be to the advantage of both road and rail transport that the "legacy of the past" should be forgotten.

Sir Reginald has not proposed specific solutions. It is unfortunate that when the British Transport Commission were relieved of the general duty of securing a properly coordinated system of inland transport this task was not delegated to any other body.

Yours faithfully,
H. O. MANCE.

18-22 Abchurch Lane,
London, EC4. 2 October, 1959.

CHIPPING OF HAND HAMMERS

SIR, In the issue of ENGINEERING for 12 July, 1957, you published an article of mine on page 48 entitled "Chipping of Hand Hammers in Service," in which 1 per cent Cr-Mo steel was suggested as a potential material for chip-resistant hammers. This steel was considered promising because of its superior ductility at hardness levels of around 600 HV, compared with that of the carbon steel normally used. It was also stated that a practical trial of 1 per cent Cr-Mo steel hammers was pending. Correspondence received since suggests that your readers will be interested in the results of this trial.

About one hundred 1 per cent Cr-Mo steel (En. 19) hammers, conforming to the dimensional and hardness requirements of B.S. 876: 1957, were made and issued to tradesmen throughout the company. After one year they were recalled for examination, 63 being recovered. Four of these (6·3 per cent) were found to have chipped. Unfortunately the results were not statistically comparable with the data on carbon-steel hammers. The trial did show that the alloy-steel hammers could withstand severe edge deformation without chipping and, taking into account the information available on carbon steel hammers (including surveys, practical trials and laboratory tests), it is, I think, fair to say that their resistance to chipping is rather better than that of the standard product. However, a more marked improvement was looked for and, while the use of 1 per cent Cr-Mo steel may be a step in the right direction, on the basis of these results, one could not justify the adoption of this steel as the standard, in preference to carbon steel.

Examination of chipped carbon and 1 per cent Cr-Mo steel hammers indicates that the chipping mechanism is the same in both cases. Martensitic bands, 0·0001 in to 0·0002 in wide, have been observed associated with chipped surfaces, indicating the very local nature of the deformation process and the high temperature attained. Judging from published work on the subject, observation of these martensitic bands is the general experience. In his article "The Micro-Mechanism of Fracture" (*Fracturing of Metals*, p. 3, American Society of Metals, 1947), C. Zener has encountered them in pierced armour plate and projectile fragments and has produced them in steel experimentally. He ascribes their formation to a process of adiabatic shear and this mechanism appears also to be the one by which hammers chip.

One implication of this is that ductility is not the only, and probably not the main, criterion for chipping resistance. If chipping is a shearing process it appears logical to select for hammers materials with the highest possible tensile strength (since they will also be strongest in shear), consistent with reasonable ductility and impact resistance. The ultra-high tensile steels, primarily developed for the aircraft industry, are the strongest at present available (U.T.S. up to 150 tons per sq. in and 0·1 per cent P.S. > 100 tons per sq. in) and examination of their potentialities as chip resistant hammer materials would be of the greatest interest.

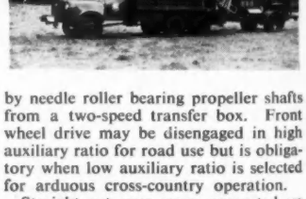
Yours faithfully,
A. H. BURN,
Engineering Developments Manager.

Imperial Chemical Industries Limited,
Billingham, County Durham.
30 September, 1959.

New Plant and Equipment

CROSS COUNTRY VEHICLE

High Tractive Power



THE DM 66 Prospector chassis is an 8 to 10 ton capacity cross-country unit designed to give maximum traction under extremely arduous conditions.

Power is supplied by a Perkins P6 or R6 engine as desired, the first developing 83 b.h.p. at 2,400 r.p.m. and the second 104 b.h.p. at 2,500 r.p.m.

Front suspension is provided by trunnion-ended semi-elliptic laminated leaf springs augmented by direct acting hydraulic shock absorbers. Positive bump control is by Metalastik rubbers reacting against the chassis frame longitudinal. Steering is of conventional commercial vehicle pattern. The rear bogie is of the fully articulating type, the single semi-elliptic spring being mounted on a central trunnion bracket. Driving and braking torque reaction is provided by tie tubes incorporating spherical phosphor bronze cups which locate on tapered shank ball-pins.

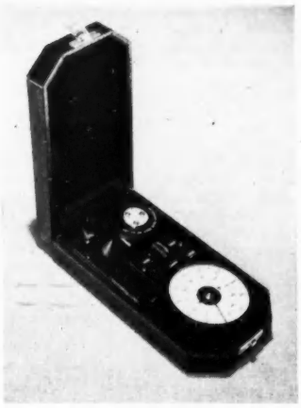
The drive to the front and rear axles, which incorporate spiral bevel reduction differential units by Hardy Spicer, is by needle roller bearing propeller shafts from a two-speed transfer box. Front wheel drive may be disengaged in high auxiliary ratio for road use but is obligatory when low auxiliary ratio is selected for arduous cross-country operation.

Straight cut spur gears supported on deep groove ball bearings and large roller bearings comprise the train in the Douglas transfer gearbox. A full torque power take-off may be fitted to drive auxiliary equipment through all primary gear ratios.

The vehicle has a tractive effort of 12,000 lb and a maximum speed of 41·2 m.p.h. Minimum speed at maximum torque is 1·44 m.p.h. The main gearbox has four forward speeds and reverse and the auxiliary box two speeds, 1 to 1 for road work and 2·2 to 1 for cross country. *Douglas Equipment Limited, Tewkesbury Road, Cheltenham, Gloucestershire.*

HAND TACHOMETER

Up to 4,000 r.p.m.



THE ATH24 hand tachometer is the fifth model to be added to the range made by Smiths. It is suitable for speeds up to 4,000 r.p.m.

Originally designed for specialist applications the ATH24 has a place where inaccuracies in reading at this range would be proportionately serious. It has three ranges, the dial being calibrated in two scales. The inner scale is for speeds from 0 to 400 r.p.m. and the outer for speeds from 0 to 2,000 r.p.m. The third range is from 0 to 4,000 r.p.m. for which the inner scale is again used.

The complete set comprises the tachometer itself; male and female rubber centres; an extension piece; and a disc for measuring surface and cutting speeds, which can be supplied for either feet or metre scales, all packed in the one case. It is claimed that speed indication is instantaneous; that the instrument is not damaged by sudden acceleration and that when desired a pointer lock can be used to hold the reading. Rotational or surface speeds can be measured to an accuracy of ½ per cent and the tachometer is unaffected by temperature or humidity within wide ranges. *Smiths Industrial Instrument Division, Chronos Works, North Circular Road, London, NW2.*

ANALOGUE COMPUTER

Patch Board Links

SHORTS are marketing a general purpose analogue computer of new design and high accuracy.

New features include an extended printed circuit wiring system and a patch board system that is claimed to eliminate cord clutter. The accuracy of components is said to be better than 0·01 per cent.

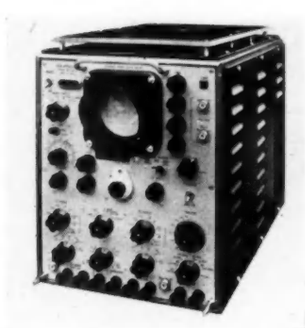
The basic instrument is a 112 amplifier linear computer but it has been so designed that specific requirements can be met by plugging the specified components in the standard racks. Up to nine non-linear components can also be incorporated if desired.

The computer consists of seven standard racks, the three control racks being confronted by a double pedestal desk. The transistorised power units are located below desk level and the measuring equipment and non-linear components (if any) above the desk level. There are 56 modules per rack and each twin unit consists of one rack of amplifiers and one rack of passive elements. The latter are maintained at a constant temperature to within 0·5° C. Drift correction factor is 1,000.

The patch boards allow up to 20,000 different connections and it is claimed that 100 cords may be employed on each panel without crossing each other. A selector panel allows any amplifier to be connected to any measuring channel, of which there are 13. The digital voltmeter and associated printer displays a four digit fraction of 100 volts and is accurate to 0·01 per cent. Extension units can bring the number of computing amplifiers up to 300 without alteration to the basic system. *Short Brothers and Harland Limited, Queens Island, Belfast.*

OSCILLOSCOPE

Double Beam Without Interaction



THE double beam oscilloscope type CD711S2 is robust and stable in all climates. It has been given Joint Service Approval.

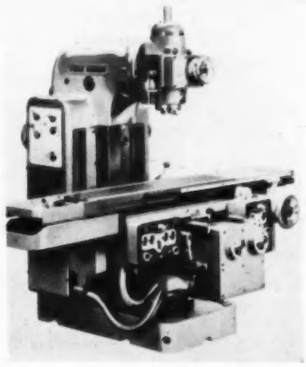
The CD711S2 is a dual channel instrument incorporating only MOS approved components. Its main features are that the Y1 and Y2 circuits are identical; there is negligible trace interaction; it has crystal controlled time markers and 4 cm pictures at 7 Mc/s. The beam switching, 150 kc/s chopping, or alternate sweeps, allows the full brightness of the tube to be used.

The Y channels have additional a.c. amplifiers providing a maximum sensitivity of 3 mV per cm. Three diameters of Y shift are available on each channel. A calibrated shift control gives amplitude measurements accurate to 5 per cent. The time base has coverage from 0·3 microsec to 3 sec with up to ×10 symmetrical expansion.

Velocity is measured by the substitution of crystal controlled time markers in the Y2 channel. These are switchable at 1 microsec and 10 microsec, or 10 and 100 microsec intervals and may be used to calibrate the screen graticule. The time base can be free running or triggered. Trigger delay is continuously variable from 10 microsec to 10 millisec in three switched ranges; fine control is by helical potentiometer. The unit weighs 118 lb and measures 18½ in high by 13½ in wide and 26¼ in deep. *Solartron Electronic Group Limited, Thames Ditton, Surrey.*

MILLING MACHINE

Range Extended



THE range of Fritz Werner finger tip controlled milling machines has been increased by the addition of six new models, two horizontal, two universal, and two vertical.

They have control of all movements by finger tip switches, seventeen automatic cycles selected by column switches and automatic cut-out of feed when the spindle speed falls below that selected.

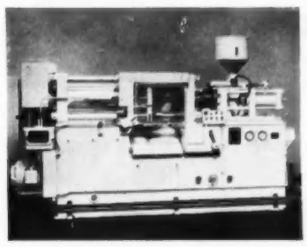
The heavy duty size 1D machines have tables that measure 43 in by 11¾ in with a longitudinal traverse of 25½ in. The standard size machines have tables of 53 in by 11½ in and a longitudinal traverse of 31 in. Cross and vertical movements on all machines are 11 in and 16¾ in respectively.

Independent motors are used to operate the spindle and table drives, the total horse power of the size 1D machines being 7½ and of the size 2 machines 9½.

All models have eighteen spindle speeds ranging from 35 to 1,800 r.p.m., or from 56 to 2,800 r.p.m., together with eighteen table feeds in each direction. Longitudinal and cross feeds range from 0·375 in to 20 in per minute or from 0·57 in to 40 in per minute. Vertical feeds are 20 per cent of these ranges. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

INJECTION PRESS

Cycle Time of 2¾ Seconds



THE Bipel injection moulding presses use a hydraulic system for operation and have very fast cycle times.

The machine illustrated covers the range from 1 to 4 oz shot and has a dry cycle time of 2¾ sec. The hydraulic system operates at 1,400 lb per sq. in and has a 6 gallon accumulator. The final clamp pressure is 4,000 lb per sq. in.

The machine can be supplied with either a 10 in cylinder for large shots at medium cycling speeds or a 6 in cylinder for small shots and fast cycling. The mould clamp cylinder is prefilled and moved by constant pressure rams balanced on the return stroke. Adjustable slow-down is included. In the heating cylinder the axis of the nozzle is eccentric with the axis of the cylinder which enables adequate heating in the form of rods to be introduced through the whole length of the spreader. Outside heating is by induction. The total heat available is 5·2 kW of which 1·5 kW goes to the spreader. The heating cylinder is capable of plasticising up to 60 lb of material per hour. The plunger end of the cylinder can be removed to enable an easy change of plunger diameter.

With a short stroke ram of 1·6 sq. in the machine can shoot 1¼ oz at 12 cycles per minute. For a 4 oz shot (with a different head) the speed is reduced to 4 cycles per min. Control is electro-pneumatic initiated by push button. Manual, single, or fully automatic, can be selected. Manual control on the main ram is direct on the hydraulic valve for tool setting. The injection assembly can be moved away by hydraulic power. *BIP Engineering Limited, Streetly Works, Sutton Coldfield.*

DRAINAGE PUMP

For Cellars and Sumps

THE Sumpette is a self-contained automatic drainage pump for use in cellars and sumps having a maximum depth of water of 2 ft 6 in.

Typical applications are buildings where surplus water is lying below the level of service drains, as may occur in boiler houses. It is claimed that the unit is economical to operate and, being portable, can be used for emergencies as for example, a burst pipe or a stopped drain.

The standard unit has a centrifugal pump driven by a ½ h.p. single phase motor. A float operated switch allows it to run unattended and there is a thermal trip in the motor. At a head of 32 ft the pump will deliver 5 gallons per minute, or 30 gallons per minute at 10 ft head. Long life and ease of maintenance are other claims; neither of the two pump bearings require lubrication and the motor bearings only once in two years. *Holden and Brooke Limited, Sirius Works, Manchester 12.*

GRINDER

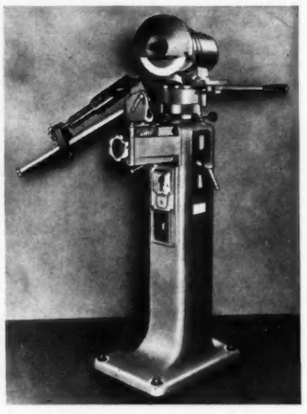
For Thinning Drill Points

THE Dormer drill point thinning machine is claimed to have several advantages.

Only one size of wheel is needed for all drills within the capacity of the machine and no special shaping of the wheel is needed. It is said that a correct modification of the core is automatically produced.

The drill is stationary during the grinding operation and is supported at the point by a conical rest and located by a V dead stop. The shank is held by a tailstock centre which can be either male or female. The drill holding unit is swivel-mounted on a slide, providing universal positioning of the drill. To simplify the operation of the machine all setting positions are marked for each drill diameter.

The grinding wheel assembly is mounted on a pivot enabling the wheel to be swung manually through the drill flute. The feed is automatic: each time the wheel is swung through the flute it



is ratchet fed 0·003 in. After one side has been ground a stop is locked so that the second side shall be ground to exactly the same amount. The machine will take two-fluté drills up to 3 in diameter and up to 24 in long. *Sheffield Twist Drill and Steel Company Limited, Summerfield Street, Sheffield 11.*

PUNCH AND SHEAR

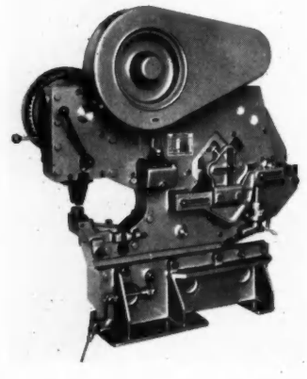
Plate up to 1 in thick

THE Valdarno universal punching and shearing machine is designed for speedy operation as a shear while retaining rigidity for punching.

The range consists of eight models giving capacities from $\frac{13}{32}$ in to 1 in thick sheet. Round bars up to $2\frac{3}{4}$ in and angles up to 8 in by 4 in by $\frac{29}{32}$ in can be cropped, using the standard blades. In the smaller sizes the number of strokes per minute can be 40 but is only 30 in the largest model. The power required is from 2·5 h.p. to 12 h.p.

The machines are driven by a three-phase motor having a star delta starter, the drive being via a V belt to the fly wheel. Two gears then drive the punching, and the cropping shearing and notching operations. A rolling key clutch enables the machine to run either on a single or automatic cycle. A friction disc acts as a safety clutch.

The punch eccentric shaft and the crop shaft turn in antifriction bronze bearings and the flywheel shaft runs on



ball and roller bearings. The fly wheel is mounted very close to the body to keep overhang to a minimum. The driving pinion on the flywheel shaft is located at each end by ball and roller bearings. *Sharston Engineering Company Limited, Wythenshaw, Manchester, 22.*

PNEUMATIC PRESS

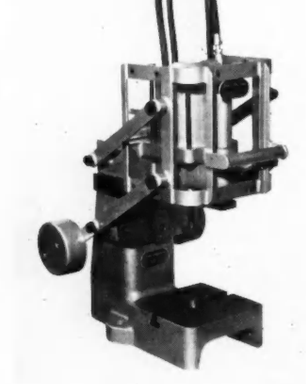
1,300 lb Thrust

THE model 1795 pneumatic press is a bench machine with a stroke of 3 in and a thrust of 1,317 lb when using air at 100 lb per sq. in.

The ram of the press is guarded by an interlock so that it cannot descend until the guard completely covers the work table. Both descent and return velocities are controllable by adjusting two separate throttle valves attached to the main valve block.

The cylinder head is adjustable over 2 in for increments of 1 in and has a maximum air gap from work table top to the underneath side of the ram of $7\frac{7}{16}$ in. To reduce fatigue the ram is counterbalanced.

The ram is bored with a hole of $\frac{1}{2}$ in $\pm$ 0·00025 diameter and the work table has in addition to a standard $\frac{1}{2}$ in T slot a centre hole of $1\frac{21}{32}$ in diameter. The machine measures 15 in long by $13\frac{1}{4}$ in wide and 20 in high without air pipes. At 80 lb per sq. in the thrust is 1,053 lb. The gap is $7\frac{7}{16}$ in and the table is 7 in by $6\frac{1}{4}$ in. The



distance from the front face of the column to the centre line of the ram is 4 in. *A. A. Jones and Shipman Limited, Narborough Road South, Leicester.*

LOW VOLTAGE TRANSFORMER

Glass Fibre Case

TO increase the safety factor of low voltage hand lamps a range of portable transformers has been produced enclosed in glass fibre cases.

The cases are filled with compound to secure the transformer in place so that screws need not penetrate the outer casing. All other external parts that are normally of metal, such as lid securing screws and cable glands, are of nylon. A great advantage of the cases is that they are not liable to corrode and do not require frequent or indeed any painting.

As a further development towards all insulated construction the transformers can be fitted with moulded rubber sockets and plugs in both 5 and 15 A sizes. The provision of keys prevents the insertion of a low voltage connection in a high voltage socket. The transformers have a centre-tapped secondary winding and a metal screen between primary and secondary windings; provision is made for earthing the centre point. Sizes are available up to

1,500 VA and with ouputs at 110, 50 or 25 volts. *Sturdy Electric Company Limited, Hamsterley Colliery, Newcastle upon Tyne.*

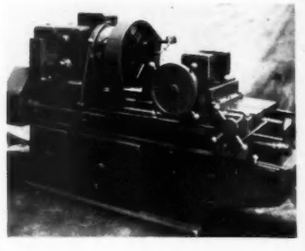
THREADING MACHINE

Up to 6 in pipe

THE MB series of tangential threading machines has been extended by the addition of one that will take up to 6 in pipes.

The standard machine is fitted with a Lanco 6 in all-steel tangential diehead having a capacity of $2\frac{1}{2}$ in to 6 in pipes. There are nine spindle speeds ranging from 9 to 73 r.p.m., and all sliding gears are hardened and fitted on splined shafts which run in ball bearings. The headstock is pump lubricated and the spindle is mounted in replaceable phosphor bronze bearings. The saddle is of narrow guide construction over a long bearing surface to provide accurate alignment and resistance to wear, while the hammer action vice reduces operator fatigue.

The machine illustrated is fitted with lead screw control to the saddle which is an optional extra. A special saddle has been fitted to allow the self-centring vice to be easily removed, leaving a completely flat machined surface on which special fixtures can be mounted, as for



instance an arrangement for handling irregularly shaped pipes. On standard models the traverse to the saddle is by rack and pinion.

The drive is by V belts from the motor to a self-contained headstock, and a geared pump supplies automatic lubrication to individual points. Provision is made for handling large quantities of swarf, removing it from the rear. A large tank and electric suds pump give an ample coolant capacity. The MB series is built on the unit construction principle providing interchangeability of parts and reduction in spares needed. *Landis Machine-Maiden Limited, Hyde, Cheshire.*

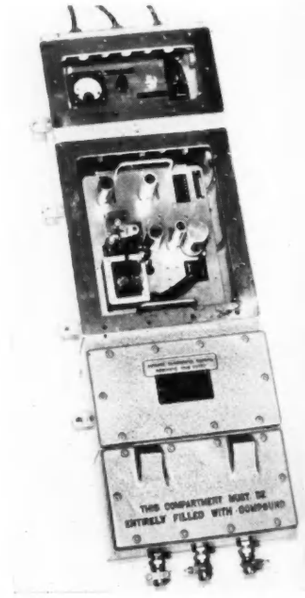
AUTOMATIC WEIGHER

Uses Standard Load Cells

AN automatic weighing equipment has been developed for use with standard load cells.

The equipment involves the use of one or more load cells of conventional type on which the load, be it hopper, conveyor section, truck, or loading platform, rests. Alternatively the load may be suspended from up to three suspension type cells. In either arrangement the load cells are connected to a remote relay unit which integrates the outputs and when the integrated current reaches the value corresponding to the selected weight, actuates the control mechanism for the conveyor motor, chute gate, automatic valve, diversion plough, or whatever is involved.

The equipment is suitable for the range of weights normally covered by standard cells, that is from 50 lb up to 1,000 tons or more, and is provided with operating adjustment over any desired range of weights. Repetitive accuracy is better than 1 per cent. *Elcontrol Limited, Wilbury Way, Hitchen, Herts.*



Special Article

Protein Production by the Impulse Process

The protein can be extracted from any vegetable matter by subjecting it to shock waves transmitted through water. Byproducts can be extracted by dissolving the protein in an alkaline solution.

For over 100 years now, it has been known that all vegetation contains protein to some extent and of many kinds. Different plant types and different parts of plants contain different proteins, and their protein content can vary enormously from plant to plant and from season to season. The protein value of many of the edible nuts and other foods such as peas, and beans has been known for many years and their value in human nutrition is well established.

Over the last thirty years, scientists have been paying increasing attention to the proteins of the vast range of vegetable materials which are not fit for human consumption but which are used extensively for livestock feeding—the oil-cake residues left after extracting edible and industrial oils from such materials as ground nuts, cottonseed or linseed, and the grasses and leafy vegetations which form the main source of food to the grazing animals that supply meat. What this attention had not produced up till now was an industrial process which could extract these proteins from the variety of raw materials in an acceptable form which could be eaten directly by human beings, at a cost which put it within the reach of everyone.

However, soon after the end of the Second World War the research and development department of British Glues and Chemicals Limited initiated a research project to improve the quality of the fats and protein products derived from its traditional raw materials, animal fats and bone. They found that the use of heat to "render" animal fats, or of hot solvents to degrease bones degraded the products, however carefully the processes were carried out. The only way out was to devise a cold process, but this left the problem of removing the fat from the cellular tissues of a bone or a piece of raw fat without using heat.

The answer was found in the impulse process invented by Mr. I. H. Chayen. If any cellular material is suspended in a fluid such as water, and subjected to a series of impulses or shock waves of sufficient intensity and frequency, the cells are burst open and the contents spill out into the water, from which it is easy enough to collect and separate them. To produce the shock waves, the process uses a machine which generates impulses by means of beaters.

The bones or fat flow in a stream of water through the "impulse rendering" machine, which applies the shock waves to the water as it passes through. In the short time during which the material is in the machine—less than a second—all the cells are completely shattered, and the water flowing out carries the fat, still solid, away from the protein. The two products can then be purified and collected separately.

The success of this principle in the field of animal fats is now industrial history. The question that then arose asked whether it could be used with equal success to open up the cells of vegetable material; and, if so, how could the protein be recovered in a pure and palatable form for human use? It took five years to find the answers to these questions. Breaking up the cells by the impulse process presented no difficulty, but separating and collecting the contents of the broken cells was another matter.

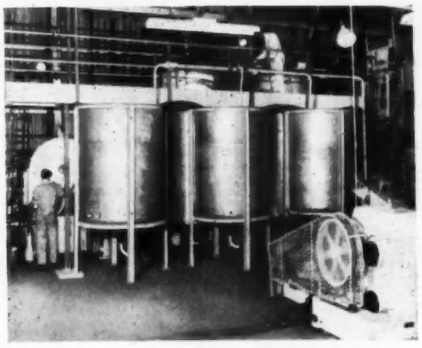
Vegetable materials are made up mainly of fibre, carbohydrates, proteins and oils. The fibre must be kept out of human food, yet it is, in many cases, a useful raw material for paper and board manufacture if it is reasonably pure. The carbohydrates may often be indigestible to human stomachs, especially some of the oil seed carbohydrates, so they must be excluded: but, they are useful for animal feeding and should be recovered. The oils are sometimes nutritional, but only in limited proportions. In all cases they are valuable in themselves and must not be lost. Again, some of the leaf materials or grasses contain valuable sterols and hormones, as well as useful but unpalatable materials like carotene and chlorophyll.

All these products are very useful separately but absolutely useless as a mixture. Their separation presents a considerable problem, particularly when one takes into consideration the overriding proviso—these things must be produced at a price which the world can afford to pay.

The solution of this problem came with another important discovery. Chibnall and Tristram had shown that vegetable protein, unlike animal protein, could be dissolved in slightly alkaline water once it was freed from the cell. Chayen now found that if the cell was broken up by the impulse process using alkaline water instead of ordinary water to carry the shock waves, not only did the protein dissolve in the water—but oil also combined with the water in this way. In a few cases where the material was very rich in oil, a portion of the oil just separated as a layer of pure oil which could be easily collected.

The insoluble carbohydrates and the fibre were then separated from the protein and oil by a continuous centrifugation process, leaving the protein-oil combination still in solution. The next step was to neutralise the solution; down came the protein and oil as a slurry, easily separable from the water. The task of drying this slurry, or splitting it into its oil and protein components, is a straightforward one now that the fibre and carbohydrates are no longer present.

Once the research work had shown the way to a successful process, the chemical engineers of British Glues set to work to build a pilot plant to carry it out efficiently and with a high degree of mechanisation. This is the plant operating in London which has now been running for some eighteen months. It is a prototype of the full-scale factories which can be set up in any part of the world where vegetation will grow, to extract the concentrated protein for feeding the local population and providing them with industries based on the byproducts.

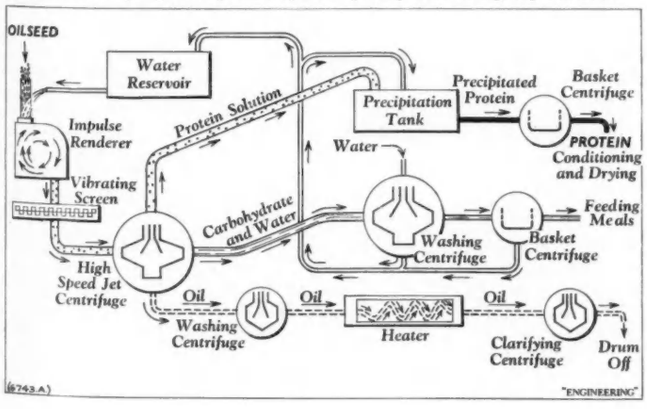


Protein precipitation in the pilot plant. On the left, an operator tends the basket centrifuge for final separation.

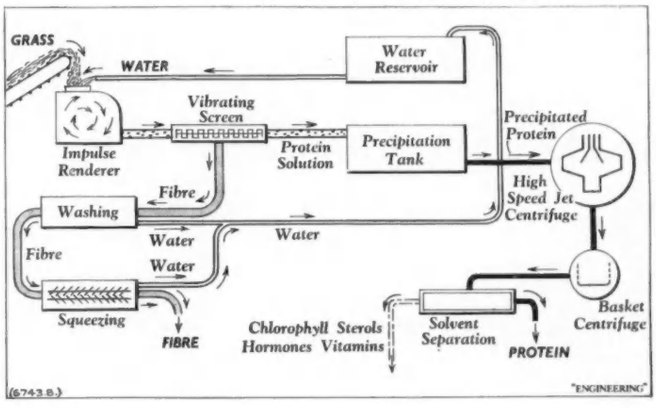
The two flow lines, illustrated below diagrammatically, for the production of vegetable protein from leaf material and from ground nuts, show the set up at the pilot plant. It can readily be modified from one raw material to the other. From 100 tons of ground nuts the process yields 25 tons of 90 per cent pure protein, 44 tons of oil, 18 tons of starch, 6 tons of water, and the balance is made up from various sugars. A standard grass, that is a grass containing 80 per cent water and 3·5 per cent nitrogen when dry, yields 5½ per cent of 50 per cent pure protein, 7 per cent fibre, and 0·6 per cent of the clorophyll syrup which contains carotine, xanthophyll, sterols and steroids, vitamin A and possibly vitamin E. These products are very valuable, and it is thought that they might pay for the entire process. The capital cost of the plant is estimated to be below 10s per head of population, if they are to consume 1 oz per day.

A vast amount of work remains to be done in investigating the many varieties of byproducts of commercial and nutritional value which arise from different types of vegetable materials. Every raw material will require its own special process modification, and will yield a different range of products. One thing, however, is now established. It is no longer inevitable that the majority of the population of this earth shall continue to suffer from the gross and chronic malnutrition caused by protein deficiency.

The production of vegetable protein by the impulse process using leaf material.



The impulse process modified to use ground nuts.



Making Britain Cooler

More work on Clydeside, where unemployment continues intractably above the national average, should follow the new arrangement for Stone-Platt Industries Limited to manufacture under licence air-conditioning and industrial refrigeration plant of the Carrier Corporation, Syracuse, New York.

Carrier Corporation, whose sales last year reached almost £100 million, claim the position of the largest air-conditioning plant makers in the world. With export sales above £20 million a year Stone-Platt are substantial partners to the American firm. Together they have formed Carlyle Air Conditioning and Refrigeration Limited, at 1 King Street, St. James's, London, SW1, with Carrier, as the marketing body, holding a controlling interest.

The trunking work, which Sir Kenneth Preston, chairman of Stone-Platt, said at the launching of the new venture was a large part of the manufacture, will be done at the works of Winsor Engineering at Glasgow, which was bought by Carrier and Stone-Platt earlier this year. In this case, Stone-Platt have the controlling interest. While Stone-Platt visualise handling the new production through existing factories the Carrier chiefs are already looking forward to a time when additional British works will have to be built.

The chairman of Carrier, a former banker, Mr. Cloud Wampler, was in London for the announcement and he proudly stated that all the atomic submarines of the free world had Carrier air conditioning, as has the Savannah. The largest centrifugal refrigerating machines ever installed in an office block (it almost goes without saying that they are Carrier made) are at the Chase Manhattan Bank, New York, and weigh 3,500 tons each.

Britain, said Mr. Wampler gravely, was a progressive country, and was now going to "get around to" air conditioning. He had some revealing examples to relate; on how often the air-conditioning plant in the great New York office blocks had to be turned from heating to cooling in the winter because of the amount of heat coming from bodies, lamps and computers. Apparently the modern computer declines to function at all without air conditioning.

The new marketing body is aimed not only at the United Kingdom but at the whole Sterling area. Although the need for home, office and plant cooling is plainly greater in many of the less developed areas of the Commonwealth it is exactly in many of these countries that the energy supplies are not yet there to run the cooling equipment.

Mr. Wampler told this tale of his own experience. He used to work in a non-air-conditioned office. (He sounded as if he was not sure he was forgiven.) Then he wore one white shirt a day and the collars and cuffs got dirty. Now, of course, he works in a fully-conditioned office—and still wears one white shirt a day. But the collars and cuffs require less attention from the laundry and he need buy only a third of the shirts he bought before.

Diesels in the Dumps

The results of leading manufacturers of diesel engines such as Ruston and Hornsby and Associated British Engineering, suggest that the industry is going through a very thin time. Ruston's directors report that "difficult trading conditions" persisted throughout the year under review (to 31 March) and that the upward trend of costs continued. Profits before tax fell by some £600,000 to £980,945. In his annual statement Mr. W. J. Ruston, chairman of the company, explained that there had been a fall in output, due mainly to the almost entire closure of Middle East markets where Rustons have traditionally done a lot of business. The after effects of the credit squeeze, the developing recession in the shipbuilding industry and rising costs were the important factors in reducing profits.

Associated British Engineering had an even worse year. They made a net loss before tax of nearly £200,000 and have now run down their reserves to a very low level. Their chairman, Mr. L. W. Robson, told shareholders that the group's troubles are still concentrated on the operations of Henry Meadows Limited who have not been able to recover from the cessation of Government contracts. The present policy is to consolidate and retrench, and Mr. David Bruce, who was managing director of British Polar Engines Limited, has been appointed deputy chairman of the present company. His task, to achieve the maximum economies in manufacture and administration, and to conserve the liquid resources of the group, is not likely to prove an easy one.

Mr. W. J. Ruston had less cause for pessimism but is nevertheless very reserved and cautious in his expectation. He also looks for a reduction in costs as the main source of improvement. It is left to a much smaller company, W. H. Dorman, to show the way. Profits before tax rose by £38,615 to £54,230 and their chairman, Mr. Darby Haddon, spoke of a better order book, saying that they could look forward to next year's results with more optimism.

Vickers Setback

The sharp drop in the trading profits of Vickers Limited came as a shock to the City. Although the company's chairman had forecast lower profits for 1959 few expected a drop of nearly £3 million to £5·17 million in the first half of this year compared with the first half of 1958. Turnover fell from £89·48 million to £73·03 million and no spectacular recovery is expected during the current half year. In fact profits are expected to be about the same as in the first six months, making for the whole year a figure some 50 per cent lower than was earned in 1958. Orders on hand at 30 June were £295 million, compared to £343 million on the same date of 1958 and £312 million at 31 December.

In this announcement of reverses the company state that declining sales of aircraft and continued slackness in certain sections of the English Steel Corporation were the main causes. There was also a lack of recovery in Canadian heavy engineering and shipbuilding and further provision for development costs of new aircraft. The amount provided under this heading during the first half of the year was £2 million, compared with £2½ million in the second half of last year and £1½ million in the first half. This is probably the first time the cost of a development programme for a large new aircraft—the Vanguard—has had to be borne entirely by one company, and its effect was to reduce the group profit from £5·17 million to £3·17 million.

Prospects are not immediately better but the group's engineering business and shipyards remain active. Taking a longer view the company report "signs of some gradual improvements in steel and Canadian interests" but not, unfortunately, in aircraft.

Activity in the Air

The British aircraft industry's search for new products to take up the slack from shrinking military business is being intensified. The rate at which civil aircraft are being developed is now quicker than at any time since the war and there is more Government support than was once thought likely. The Short SC5 Britannic freighter is a good example of what is being done. The Avro 748 and the Vickers Vanguard are others. All these aircraft are aiming at the short to medium haul market for low cost air transport. The British industry has accumulated considerable experience in the construction of aircraft with excellent performance over ranges of 500 to 2,000 miles, able to land and take off on short runways and suitable for either passenger or freight duties.

The Short freighter was originally conceived as a carrier with a 25,000 lb payload and a maximum range of 2,300 miles (the Short PD16). Short Brothers and Harland did not, however, find it practicable to develop this project as a private venture but continued to investigate the air freight market. It was during discussion with KLM, who are one of the world's leading freight was developed. The choice of the turbopropeller carriers, that the idea of a very large freighter power units in preference to pure jets was dictated by the twin needs to have an aircraft able to use existing airfields all over the world and to keep the cost relatively low. The latest development of the design, the Britannic 3A, has an all-up weight of 218,000 lb and a payload of 85,000 lb. It can carry this load over 1,150 statute miles at 340 m.p.h. with a 20 per cent reserve of its 81,200 lb fuel capacity or 25,000 lb load over 5,050 miles at the same speed, again with adequate fuel reserves. Assuming 66 per cent load factor and indirect costs of 9*d* per ton-mile the Britannic makes possible total operating costs which are roughly less than 18*d* per ton-mile for a stage length of 2,500 miles—that is to say, half current European airline freight rates. The Britannic 3A is currently being developed for the RAF Transport Command with whom it will be in service in 1964.

The Britannic reflects the conviction of its builders that there is a vast potential market for aircraft which, they say, "must develop before long into a major industry comparable with passenger transport."

Lessons from Germany

The Mannesmann group of companies have been reorganised into a more closely knit and much stronger unit. The reorganisation, which is discussed in the company's annual report, followed a period of falling turnover in practically every one of their activities. Output of tube of Mannesmann AG and their German subsidiaries dropped by 7·6 per cent during 1958. Seamless tubes fell by 13·8 per cent to 462,000 tons and welded tube of diameter less than 200 mm fell by 5·3 per cent to 118,000 tons. These heavy losses were offset but only to a limited extent, by a rise in the output of large diameter welded tube to 172,000 tons. The company's output of crude steel dropped by 9·2 per cent to 1·81 million tons and their coal mines' pithead stocks rose considerably. By May of this year they had passed a million tons, and were equivalent to 49 days' output.

The group's German companies had total sales to outside customers amounting to DM 2·603 million compared with DM 2·769 million in 1957. Exports of the German group fell by 14 per cent after rising by as much as 47 per cent in 1957. The labour force of the German companies fell from 76,400 in 1957 to 73,600 but employment by foreign subsidiaries rose from 3,000 to 4,892. This is indicative of the growing interest of the group in spreading their investments to other countries. They own companies in Canada, Brazil, Turkey, Spain, Sweden, the USA as well as in Common Market countries. The report states Mannesmann's intention is to increase their holdings in the French company Société des Usines à Tubes de la Sarre in which they have a 40 per cent holding.

There is little doubt that Mannesmann in common with other large German concerns, believe that stability of trading is closely affected by the bargaining power and therefore by the size of the company. Another factor is almost certainly the conviction that the advent of the common market will favour large units. It is this growth process which may prove Britain's main competitive danger in other world markets.

Life at Imperial College

Last weekend the first Imperial College students moved into Weeks Hall, number one of the college's halls of residence in the Princes Gardens scheme and the college at last began moving away from its position as one of the least well off in Britain for residential facilities.

£150,000 given by Vickers in 1957 has covered the cost of the hall and strengthened the practice of industrial benefaction to universities carrying on where the former stream of private gifts has been dried up by the fierce heat of taxation. Lord Weeks was chairman of Vickers from 1949 to 1956 and is now chairman of the Finance Corporation for Industry, while remaining on the Vickers board.

Sir Patrick Linstead, Rector of the college, explained at the opening of the hall on the last day of September that, excluding the 67 students who will have study-bedrooms there, only 150 of Imperial College's 2,650 students could be found residential accommodation. The scientist and the engineer were attaining to more and more responsibility in the world of affairs, the universities were drawing on an ever-widening social cross section of the nation's talent, which made, in Sir Patrick's words, properly conducted halls of residence " of immeasurable value."

Lord Knollys, the present chairman of Vickers, drew a picture, in full Oxbridge style, of future students sharpening their powers of argument in the common room of the hall, continuing the discussion in the sylvan surroundings of Princes Gate, " ending up, sprawled out, still talking, in their own rooms."

Weeks Hall, built in the north-east corner of Princes Gardens, is an architectural part of that side of the college's three-sided development of the gardens, a scheme which will eventually house about 1,200 students. The hall is also to be used in vacations for Vicker's educational and staff conferences.

And the irreverent student who enters Weeks Hall in the future and looks upon the donation as a remote boardroom exercise will be wrong. Lord Knollys checked to see that he had adequate cupboard room, and he may be sleeping on the very mattress that the chairman pounded, to make sure that " the springs were about right."

Absorbing Chemistry

A new formula to make the study of chemistry a vital and absorbing task has been devised by the John Hopkins University in Baltimore, Md., United States of America. The problem, which is no less acute in this country, was to remove the dullness from the subject as taught in most schools. The John Hopkins University have found a solution partly by more appropriate segregation of students—325 freshmen were split into 12 sections according to background and ability—and partly by the use of new teaching methods based on advanced laboratory equipment. The new course, said to be " the result of more than three years of study, planning and inventive revision," is described in an article entitled " New Formula for Freshman Chemistry " published in the August/September issue of the *Du Pont Magazine*.

Right from the start of the course students found themselves spending fewer hours in the lab than freshmen usually do and working with the latest type of equipment. Lectures and lab sessions were coordinated and experiments closely related. New teaching aids were acquired —with financial support from the National Science Foundation—which helped students to master " an up dated chemistry course that included a look at thermodynamics and quantum mechanics." Professor Donald Hatch Andrews, director of the programme, had attempted to bring about the change in 1955 in order to take into account the advances in atomic science and thermodynamics and to give the students " a more mature approach to the subject," emphasising that " Freshman chemistry mustn't ever be a static thing in a day when changes in scientific knowledge come so rapidly."

President's Three-Part Tour

Professor A. J. S. Pippard, F.R.S., President of the Institution of Civil Engineers, is visiting West Africa as a part of a programme arranged by the Civils, the Mechanicals and the Electricals to keep in touch with their joint groups of overseas members.

The West African joint group, set up in 1953, has four branches—in Ghana, Northern Nigeria, Eastern Nigeria and Western Nigeria. Professor Pippard is calling on leading government ministers, educational establishments and engineering projects, and this week addressed a meeting of the joint group at Lagos.

Travelling with the President, and to some extent over familiar ground, is the secretary of the Institution of Civil Engineers, Mr. A. McDonald, a former Inspector-General of Works, Nigeria.

Housing Management Under Fire

In spite of pre-occupations with the general election, the Minister of Housing and Local Government has seen fit to express some clear hints about the quality of housing management by some local authorities. Addressing the recent annual conference of the Institute of Housing he said that while most people would agree that the fundamental principles of housing estate management have gradually evolved, diversities of practice had not narrowed sufficiently. He drew the attention of local authorities to the report called " Councils and their Houses " put out this year by a sub-committee of the Central Housing Advisory Committee.

One of the recommendations in this report to which he drew attention was that dealing with a national standard system of costing which would enable comparisons to be made throughout the country. This sort of proposal is one which local administrators naturally view with mixed feelings. Figures can be mis-used and the national figures, for example, for the hospital service, showing cost per patient and so on have been given widely varying interpretations by different people.

Despite the suspicions which such figures create and the need to use them with care, the case for a standard system of costing is a strong one. In few fields might it throw up more differing results than in housing.

Artists of the Air

The sixth annual exhibition of the Society of Aviation Artists opened at Guildhall, London, on 22 September. This year there has been a special Royal Air Force section including work from 39 members of home and overseas commands. Among these have been entries from Technical Training and from Maintenance and Signals Commands. It is hoped that some of the RAF paintings will be included in the selection made for a tour of municipal galleries in the United Kingdom after the exhibition.

By tradition it has been the Navy which has been the main source of artistic inspiration in the past, perhaps because of the popular appeal of HM ships in time of war though there have been no lack of stylised paintings of military subjects in the last century or two. Does the publicity given to the RAF participation in the exhibition hint at the ascendancy (if such there be) of things of the air, not least guided missiles? There is certainly a link between technology and art and this may be one sign of the impact of the conquest of the air—and space—on non-technical creative work.

Loss to World Bank

Mr. Henry Riley, treasurer of the World Bank, died at Washington, DC, last month, at the age of fifty-seven. He has been known on this side of the Atlantic as a principal negotiator on behalf of the bank over a period of years.

He was by training an accountant and began his public service with the US Treasury. He also had experience with the Federal Deposit Insurance Corporation, the Alien Property Custodian, the Foreign Economic Administration and the US Commercial Company. He was later vice-president of the Export-Import Bank. He became treasurer of the bank in 1953 and in 1956 was also appointed treasurer of the International Finance Corporation.

Personnel Change at CEB

The chief personnel officer of the Central Electricity Board has resigned as from 30 September and his place has been taken by Mr. Harold C. Spear, formerly chief personnel officer to the British Airways Corporation. Although it will be no change for Mr. Spear from one public corporation to another, there will be a big change in industrial atmosphere. The stormy human relations of the airways corporation has no counterpart in the electric supply industry.

The retiring chief personnel officer, Mr. S. S. Scott, has been with the board since its inception and is to continue for some months as an adviser on labour relations. These kinds of arrangements are common. They offer some continuity of expertise to the organisation and a delay for the official in the start of his living on his pension. The advantages for the incoming incumbent are not always so obvious and their use should always be with discrimination.

Good Health at Vickers

The recent opening of a new medical centre serving Vickers-Armstrongs in Newcastle upon Tyne emphasised the growing importance the Vickers group attach to the prevention of disease and the prompt treatment of accidents among their employees. Under the direction of Dr. D. McLean, the medical centre serves the company's Elswick and Scotswood works. It is unusually large for industrial medical facilities, consisting of a two-storey building opposite the main entrance to the Elswick works with a total internal floor area of 4,156 sq. ft. It is fully equipped with an X-ray room, operating theatre and physiotherapy department.

The company's stated aims for their medical services are very comprehensive. They are first of all to provide the best possible treatment for those who are injured or become ill at work " so that they either remain at work or are restored to full health and function as quickly as possible "; to provide close liaison between the employee's family doctor and other services provided under the National Health scheme and those available within the company.

Other important functions are to make the most efficient use of the manpower available by pre-employment medical examinations, re-examination of those who have been ill or injured before recommencing work, and regular examination of those exposed to particular hazards. They also advise management on problems of hygiene and accident prevention and are responsible for the education of workers on all matters affecting safety and health.

E Maximis Minima

A HIGH-ENERGY particle accelerator costs from seven to fifty million pounds, weighs many tons, and produces tiny particles. There are now ten of these machines under construction or in the final stages of planning throughout the world. Altogether 29 countries participate in the programme, either by constructing their own accelerators, or through community projects such as the 13-member European Organisation for Nuclear Research (CERN), or its 12 member Eastern counterpart at Dubna, USSR. In July, 370 scientists attended the annual international conference on high energy physics in Kiev; and in September, 250 met for the conference on high energy accelerators at CERN.

briefly into existence following high-energy collisions of protons, and their tracks to annihilation have been traced. The existence of some 30 subatomic particles is suspected, but direct evidence is missing for many, very flimsy for others. Almost half of the particles belong to " anti-matter ", the existence of which was predicted from considerations of relativity applied to quantum mechanics. Particles of anti-matter have the same mass as their counterparts, but have opposite charge and spin. As a consequence mutual annihilation follows the meeting of related particles of matter, and anti-matter can exist only briefly in this world. Table I shows a list of elementary particles (without their anti-matter counterparts), their properties and classification. It is based on an article " Elementary Particles " by P. E. Hodgson published in Penguin *Science News*.

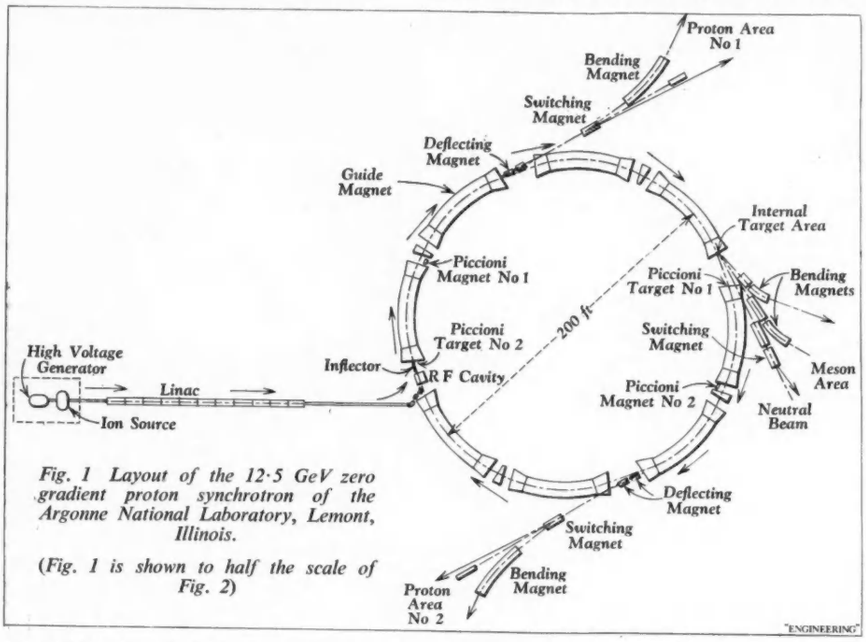
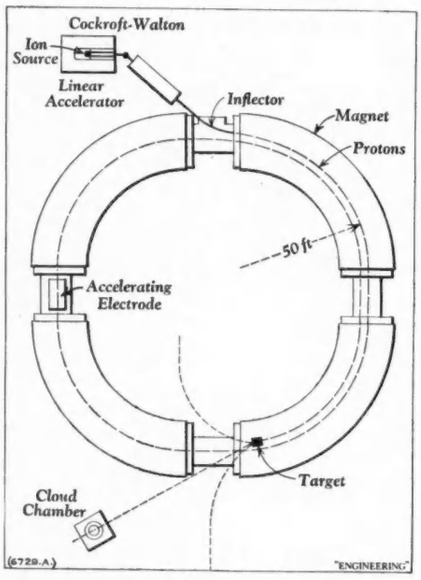


Fig. 1 Layout of the 12·5 GeV zero gradient proton synchrotron of the Argonne National Laboratory, Lemont, Illinois.

(Fig. 1 is shown to half the scale of Fig. 2)

Fig. 2 (below) 6·3 GeV strong focusing synchrotron of the University of California.



Not Only Intellectual Curiosity

The explosive growth of interest in high-energy physics was precipitated by the suspicion that subatomic particles of large mass and very short life could exist. These " strange particles " come

Status of Collation

All particles in the list making up ordinary matter have been observed and documented. In the group of anti-particles, the threshold of energy for producing neutrons and protons is above 5 GeV, and there is ample proof of their existence. Table I shows that all the hyperons have greater mass than the nucleons, so that the threshold for producing the lambda-hyperon, the lightest, is about 6·3 GeV. It is not surprising that at this time only two photographs, those obtained with the 6·3 GeV Bevatron of the University of California, serve as direct evidence for the existence of the lambda anti-hyperon; while the existence of the five heavier anti-hyperons is only inferred. There is only one other machine in operation that has the required energy for the task—the 10 GeV proton synchrotron at Dubna—but this machine is at present tied up with lower energy research. Not only is this situation intellectually unsatisfactory, but it leaves serious gaps in the chain of scientific knowledge. To the scientist accustomed to the rationalisations of Newton, Bohr, Einstein and Heisenberg, the existence of 30 odd " elementary " particles looks highly suspicious. His suspicion grows to alarm when it is suggested that perhaps more, even heavier particles might exist. The Chinese scientist Wang Kang-chang, working at Dubna, indicated the discovery of just such a particle at the Kiev conference. But a mere listing of particles will not suffice; attempts will be made to discover the relationships which govern the interaction of these particles over very small distances.

Consolidation

In an attempt to rationalise the bewildering spectrum of particles, it is now proposed that hyperons themselves have components held together by sub-nuclear forces, whose particulate manifestation is the meson in a fashion analogous to the pion—nuclear force, and the electron—atomic force relationships. In order to verify or to disprove these hypotheses yet more powerful accelerators are needed. In this connection they will have a dual function: to produce the full range of strange particles by high energy collisions; and to provide a very short wavelength (that is: highly energetic) beam with which these particles can be examined. In order to make a particle manifest, the beam with which it is observed must have a shorter wavelength than the diameter of the particle itself, and 45 to 50 GeV machines are being constructed, while 100 GeV machines would be welcomed by the scientists.

Budgetary Limit

The ultimate limit to the maximum attainable accelerator energy is the money available. The 10 GeV proton synchrotron at Dubna required 36,000 tons of steel for the magnet; this was 0·1 per cent of the Soviet Union's steel production in 1957. Linear accelerators may be built to any desired energy by adding more accelerating sections to the machine, but owing to the increasing velocity of the particles as they shoot along the path, the additional sections have to be longer and longer for the same increment of velocity. The 45 GeV Stanford University electron linear accelerator will be two miles long and will require heavy shielding along its entire length.

Saturation Limit

The performance of proton synchrotrons is limited by the need for large magnets which keep the particles in a circular path. Within the budgetary confines that limit the supply of magnet steel, the maximum energy attainable depends on the magnetic saturation of the steel. The magnets usually serve not only to keep the particles in orbit, but also to focus and control the beam by means of a magnetic gradient. To permit shaping the magnetic field, the field strength has to be kept below 16,000 gauss to avoid local saturation effects, so that only some 65 per cent of the magnet's capacity is utilised. The available resources may be used to produce high-energy low-intensity beams in strong focusing machines, or lower-energy but much more intense beams in weak-focusing machines, the two types being complementary to each other. The impasse is broken in the Argonne zero gradient synchrotron, where, since focusing is accomplished by shaping the edge of the magnet sections, the magnet steel's full capacity of 21,500 gauss is utilised. Figs. 1 and 2 compare the

Table I.—Elementary Particles: Classes and Properties

—	Particle	Spin	Isotope Spin	Strangeness	Charge	Lifetime (sec)	Mass (electron) units)	Symbol
BOSONS	Photon	1	—	—	0	Stable	0	γ
	Pion (π^0)	0	1	0	0	$\sim 10^{-16}$	264	π^0
	Pion ($\pi\pm$)	0	1	0	± 1	$2{\cdot}8 \times 10^{-8}$	273	$\pi\pm$
	K_1^0-meson	0	$\frac{1}{2}$	+1	0	$1{\cdot}0 \times 10^{-10}$	967	θ_1^0
	K_2^0-meson	0	$\frac{1}{2}$	+1	0	$\sim 10^{-7}$	967	θ_2^0
	$K^{\pm}$-meson	0	$\frac{1}{2}$	± 1	± 1	$1{\cdot}2 \times 10^{-8}$	967	$K^{\pm}$
FERMIONS	LEPTONS							
	Neutrino	$\frac{1}{2}$	—	—	0	Stable	0	γ
	Electron	$\frac{1}{2}$	—	—	± 1	Stable	1	$e\pm$
	Muon	$\frac{1}{2}$	—	—	± 1	$2{\cdot}2 \times 10^{-6}$	207	$\mu\pm$
	BARYONS							
	NEUCLEONS							
	Proton	$\frac{1}{2}$	$\frac{1}{2}$	0	+1	Stable	1,836	p
	Neutron	$\frac{1}{2}$	$\frac{1}{2}$	0	0	$1{\cdot}1 \times 10^{3}$	1,839	n
	BARYONS							
	HYPERONS							
	Λ^0-hyperon	$\frac{1}{2}$	0	−1	0	$2{\cdot}8 \times 10^{-10}$	2,182	Λ^0
	Σ^+-hyperon	$\frac{1}{2}$	1	−1	+1	$0{\cdot}8 \times 10^{-10}$	2,328	$\Sigma+$
	Σ^0-hyperon	$\frac{1}{2}$	1	−1	0	$\sim 10^{-10}$	2,330	Σ^0
	Σ^--hyperon	$\frac{1}{2}$	1	−1	−1	$1{\cdot}6 \times 10^{-10}$	2,342	$\Sigma-$
	Ξ^--hyperon	$\frac{1}{2}$?	$\frac{1}{2}$	−2	−1	$\sim 10^{-8}$	2,584	Ξ^-
	Ξ^0-hyperon	$\frac{1}{2}$?	$\frac{1}{2}$	−2	0	?	2,584	Ξ^0

TABLE II.—*Proton Synchrotrons above 5 GeV*

Energy, GeV	Location or name	Diameter, ft	Magnet weight, tons	Magnetic field, kilogauss	Type	Status
25–30	Brookhaven	560	4,000	12–14	Strong focusing	Under construction
25–50	CERN	650	3,200	12–14	Strong focusing	Operating
7	Moscow	115	—,	—	Strong focusing	Under construction
50	Moscow	1,640	22 000	—	Strong focusing	Planned
7	Harwell, Nimrod	150	7,000	14	Strong focusing	Under construction
6·3	Berkeley, Calif.	125	9,700	16	Weak focusing	Operating
10	Dubna	200	36,000	13	Weak focusing	Operating
12·5	Argonne ZGS	200	4,000	21·5	Zero gradient	Under construction

layout of two related types, the 6·3 GeV weak focusing machine in Berkeley, California, and the zero-gradient synchrotron of the Argonne National Laboratory in Lemont, Illinois. Table II contains engineering properties of some high-energy proton accelerators in operation, under construction or planned.

Particulate Matter

All processes involving the production and decay of the fundamental particles shown in Table I are subject to the laws of conservation of charge, energy, and momentum. Also, the number of baryons minus the number of anti-baryons remains the same throughout any reaction; a similar law holds for the conservation of leptons. Particles whose numbers are conserved have half integral spin and are called fermions—they obey Fermi-Dirac statistics. Particles whose numbers are not conserved—pions, K-mesons, and photons—are of integral or zero spin and called bosons. They obey Bose-Einstein statistics. There are some conservation laws that are obeyed only approximately: strangeness, and parity. Reactions conserving strangeness—a quantum number needed to interpret the experimental data on K-mesons and hyperons—proceed more easily, while reactions in which strangeness changes by one unit proceed only slowly and with difficulty. Parity is conserved in strong interactions involving nucleons, but may not be conserved in weak interactions, involving leptons. Parity is conserved in some strange-particle interactions, but not in others.

Structure of Neutrons

In a paper "Structure of the Neutron," by K. Tanaka (*Phys. Rev.*, vol. 113, No. 2, p. 714), the contribution of the nucleon current to the electromagnetic structure of the neutron is derived by use of the dispersion relations for neutron-proton scattering, with consideration restricted to the contributions from the one-pion and two-pion states of the nucleon-nucleon scattering. It is found that both states reduce the neutron-electron potential, that is, lead to a smaller charge radius of the neutron. The calculation shows the resulting mean-square radii of the neutron to be $(0{\cdot}23 \times 10^{-13}\ \text{cm})^2$ and $(0{\cdot}41 \times 10^{-13}\ \text{cm})^2$ for the charge distribution and the magnetic moment distribution respectively. The contributions of meson and nucleon current are included.

Anti-Neutrino

Experiments on anti-neutrinos that yield results consistent with the two-component theory of the neutrino but not with the four-component theory are described in the January issue of *Physical Review*. On page 273, F. Reines and C. L. Cowan, Jr., describe how the cross-section for the reaction $p(\bar{\nu}, \beta^+)n$ was measured for nuetrinos from a fission reactor at the Savannah River plant of the US Atomic energy Commission. Target protons were provided by a 1·4 kilolitre liquid scintillation detector in which the scintillator solutions—triethylbenzene, terphenyl, and POPOP—was loaded with cadmium octoate to allow the detection of the reaction by means of the delayed coincidence technique. (The first pulse of the pair was caused by the slowing down and annihilation of the positron, the second by the capture of the neutron in cadmium following its moderation by the scintillator protons.) A second large scintillation detector, without cadmium loading, above the first, provided an anti-coincidence signal against events produced by cosmic rays. The anti-neutrino signal was related to the reactor by means of runs with the reactor on and off. A differential shielding experiment ruled out reactor radiations other than anti-neutrinos as sources of the signal. A measured cross-section per fission of $(6{\cdot}7 \pm 1{\cdot}5) \times 10^{-43}\ \text{cm}^2$ was obtained, consistent with the two-component theory. The signal rate was about 36 events an hour.

Anti-Neutrino Cross-Sections

Measurement of the electron spectrum from the thermal neutron fission of uranium 235 is described by R. E. Carter, F. Reines, J. J. Wagner, and M. E. Wyman (page 280). From this spectrum the anti-neutrino spectrum is calculated and on the basis of the two component theory of the neutrino a predicted average cross-section for the absorption of anti-neutrinos by protons is obtained. The value, $(6{\cdot}1 \pm 1) \times 10^{-43}\ \text{cm}^2$ per fission, agrees with the measured value cited above. The predicted value according to the four-component theory is $(3{\cdot}05 \pm 0{\cdot}5) \times 10^{-43}\ \text{cm}^2$ per fission.

Epoxy Resin at 7 GeV

Irradiation of resin glass-fibre samples with doses of greater than 10^9 rads reduces their cross-breaking strength by more than 50 per cent; it also causes delamination, probably by changing the structure of the resin. Thus the proposed resin glass-fibre vacuum chamber for the Harwell 7 GeV machine Nimrod is not suitable in its present form, owing to its high stress loading. If an outer structure were used to sustain the main vacuum loading, a glass-fibre inner chamber would be an effective envelope for doses in excess of $2{\cdot}5 \times 10^9$ rads—provided the vacuum properties were not impaired by radiation.

(Report A/R: "The effects of proton and neutron irradiations on an epoxy resin vacuum chamber proposed for the Harwell 7 GeV proton synchrotron," by R. J. B. Hadden and W. Spittle. Price 3*s*.)

Construction Starts on Argonne Synchrotron

Ground breaking ceremonies were performed for the construction of the 12·5 GeV Argonne zero gradient synchrotron in Lemont, Illinois. Major phase of the contract will be the installation and alignment of the magnet. To avoid differential settlement the magnets will be supported on bedrock by 90 ft concrete caissons. A mound of earth will shield the surrounding buildings from high-energy radiation. Three experimental buildings, a laboratory, machine shops, office building and a cooling tower for the magnet cooling system will complete the site. The expected cost of the installation will be $29 million.

CERN Synchrotron "Critical"

The 25 GeV proton synchrotron of the CERN laboratories in Meyrin was operated for the first time at midnight on 16 September. Full power operation is not expected until early next year. The successful acceleration of a proton beam indicates that the critical alignment of the 100 magnet units has been successful.

Magnets for Nimrod

Contracts to the value of £430,000 have been placed for the supply of magnet coils for the 7 GeV proton synchrotron Nimrod. (Atomic Review, 12 June, '59) British Copper Refiners Limited supply copper billets; James Booth and Company extrude rectangular hollow conductors; while Metropolitan Vickers fabricate the finished coils.

50 MeV Harwell Linear Accelerator Operating

The 50 MeV proton linear accelerator of the Rutherford High Energy Laboratory reached its design energy for the first time on 12 July. The accelerator was designed and constructed by Metropolitan-Vickers in collaboration with Harwell scientists. The machine has three accelerating cavities in which the proton energy is successively raised from 10 to 30 to 50 MeV.

Low Frequency Klystron Tube

Development of a klystron power tube capable of operating at 1,300 megacycles, and promising considerable economies in the operation of particle accelerators, has been announced from the United States. The tube has four to six times longer life than those employed at present, and operating at 2,855 megacycles. The need for periodic replacement of this component, costing approximately $15,000 each, is a major item in the operating cost of particle accelerators.

Rome Synchrotron

An interim progress report on the 1 GeV electron synchrotron at Rome has been given in a paper by G. Salvini (*Nuovo Cimento* Suppl., vol. 9, No. 2, p. 402). The magnetic segments are being aligned and the condenser banks have been installed. Correcting and defining coils have been tested and focusing problems are being investigated, together with a preliminary study of beam extraction. Work is in progress on the installation of controls, beam measuring devices are being constructed, two beam deflecting magnets have been completed, and counting circuitry is being made up.

Medical Accelerator for Australia

A 4 MeV linear accelerator for the treatment of deep-seated tumours is to be built by Mullard for the Cancer Institute Board of Victoria. The company has already supplied three similar accelerators for hospitals in the United Kingdom.

Power Programme Comment

The following are comments of a special correspondent related to recent important developments in the United Kingdom nuclear power programme.

Power from AGR by 1966

The Central Electricity Generating Board stated recently that a commercial advanced gas cooled (AGR) power reactor may be designed and built before full operating experience is obtained from the Windscale AGR now under construction. Stainless steel canning will be used unless experience with the Windscale reactor shows that beryllium canning is essential. If stainless steel sheaths are satisfactory the reactor may be in use by the end of the current nuclear power programme in 1966. It was suggested that the rating of the first power producing AGR would be 300 MW—presumably electrical—per reactor. It seems reasonable to assume that construction will take just about four years; to be ready by the end of 1966 building must start in 1962. As a result most of the designing and planning must be finished by 1961 even if there is room for alterations in the final core structure. As the Windscale AGR will only just start working then, very little operating experience will have accumulated when construction starts. Main features of the power cycle, containment, pressure vessels, and auxiliary equipment will have to be fixed without previous experience, although loop test results may be available. In some ways the decision for early construction of a power producing AGR suggests a courageous repetition of the Calder Hall story, with a decision to build before proving the design in a full-scale experiment.

Consequences of Stainless Steel Canning

The decision to use stainless steel is interesting since to date most of the information from the UKAEA has tended to stress the use of beryllium for the AGR and merely state that stainless steel is available should trouble arise with beryllium. The general impression has been that the UKAEA have more or less the answers needed for the manufacture and welding of beryllium, in fact the ICI beryllium plant at Birmingham is soon expected to start making AGR fuel cans. If the CEGB prefer stainless steel, the question arises if enough is known in Britain about the behaviour of stainless steel and its welds under long-term high-flux irradiation. Presumably loop tests and a good deal of metallurgical work are in progress somewhere. Of interest is the fact that stainless steel has a much greater neutron absorption cross section, and hence needs higher enrichment than beryllium. This could influence ideas on the type and scale of gaseous diffusion plant needed to cope with the future power programme which it would seem will be based in a few years on oxide fuel enriched to about 1·5 per cent, or roughly twice the value for natural uranium. There is also the question of coolant: helium, not carbon dioxide, is proposed for the American gas-cooled reactors, which also employ stainless steel canning; though the GEC reactor proposal described last week will have both carbon dioxide coolant and stainless steel canning.

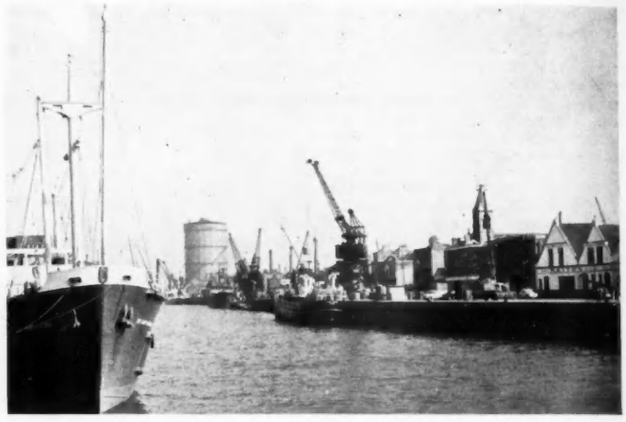
Speculation on Power Station Capacity

Currently, 86 per cent of the fuel used for electricity generation is coal and 12 per cent oil. The CEGB expects that this will slowly change to about 80 per cent coal, 11 per cent nuclear and 8 per cent oil by 1965. A spokesman of the generating board remarked that the first seven stations would have a total capacity of almost 4,000 MW. Since Bradwell, Berkeley, Hinkley Point, Trawsfynydd and Dungeness add up to 2,100 MW, about 1,900 MW are left for Oldbury and Sizewell, which would make them considerably larger than expected. This means either that the generating board has decided to make additions to existing stations or decided to accept much larger ones in the future. In either case a move away from the present two-reactor station is indicated.

Engineering Expands in Irish Republic

Engineering in the Republic of Ireland, is growing. It is backed by appropriate developments in the fuel, power and transport fields, and it receives official encouragement from the Government. An oil refinery recently opened by the Prime Minister is the biggest single industrial development in Eire since the Shannon Scheme.

Many things spring to mind at the mention of Ireland—tourist attractions, whiskey, glassware, fabrics, racehorses, to name only a few. All these things and many more it has, of course, and in good measure, but it is possible to overlook the fact that the Republic has developed its manufacturing facilities in many other fields as well. Large assembly plants have existed in Ireland for some years for producing cars and trucks from imported CKD parts, for example. Vehicle tyres are made there, and so are radio sets and many other products which require engineering equipment and skill for their production. To these established industries there are now being added various others which have not before been represented in Ireland, and expansion is taking place in the older fields, too.



(Above) Reaching almost into the heart of the City, Dublin docks provide sea communication with the world.

GOVERNMENT POLICY

The Eire Government has set up a statutory body, the Industrial Development Authority, 14 St. Stephen's Green, Dublin, to stimulate the development and expansion of Irish industry, and charged, specifically, with the task of assisting industrialists in other countries who may be interested in establishing manufacturing plants in Ireland. During the past four years over 30 new factories have been set up in Ireland by overseas concerns, and plans for several more are complete. These are additional to the many new factories opened by Irish interests.

To help industrialists the government makes substantial grants for the erection of new factory buildings, which may extend up to the full cost, and grants are also made for plant and machinery and the training of workers. Important tax concessions are made, and investors are allowed to transfer dividends, interest and profits in their own currency. Capital, too, together with capital appreciations, can be repatriated at any time.

In the case of certain specified industries, such as metal mining, which in its development stages involves the mine operators in unavoidable financial risks, special tax concessions are made. The 1956 Finance Act provided that in the case of all new mines coming into production before 6 April, 1961, no income tax or corporation profits tax would be levied in the first four years after commencement of production, and that for the next four years half the profits would be exempted from these taxes. An immediate consequence of this Act was that a company financed by Canadian capital started work in an old mining district at Avoca, Co. Wicklow, and they are now producing copper ore on a large scale. Lead and zinc are being worked there also, though to a smaller extent.

It is not given to every country to be well endowed with natural resources, and it is well known that Ireland has very little in the way of solid fuel except peat (known as turf in Ireland). There are coal mines at Arigna, Co. Leitrim, and high grade anthracite is produced at Castlecomer, Co. Kilkenny, but the quantity is small, such that large scale development is unlikely

Turf, however, is a different matter. Very large areas of this fuel occur in Ireland, and the Turf Board (Bord na Mona) is responsible for large outputs, a considerable proportion of which goes to the Electricity Supply Board for use in their power stations. Some turf is used for other purposes, and some is exported. Turf production in some areas is highly mechanised.

But it is to oil that many people look today. Ireland has been until recently, wholly dependent upon imports for oil products, but a new refinery at Whitegate, Co. Cork, which was opened officially at the end of last month, is planned to meet the needs of the home market. Designed for an annual throughput of 1½ million tons at first, rising to 2 million tons later, the refinery ranks as the biggest single industrial development in Eire since the Shannon hydro-electric scheme came into operation some 30 years ago.

Making most of the products obtained from crude oil, the new refinery is operated by the Irish Refining Company Limited, in which Caltex, Esso, Shell and BP are jointly interested. Built at the entrance to Cork harbour, the refinery has a jetty capable of accommodating, at present, tankers of up to 37,000 tons d.w. The design of the jetty allows for dredging in the future to accommodate 65,000 ton ships. A small island between the berthing point and the shore has been used for the tanks for crude oil and finished products, the latter being shipped by coastal tanker from the same jetty.

Although the refinery follows, in general plan, the design of other modern plants, it possesses some unusual features. The flare stack is of a new design and is the second of its type to be installed in Europe. Only about 30 ft high and 20 ft diameter, the stack is of steel with a refractory lining, and has multiple burners raised above the air intake, which is provided with a louvred wind shield. Combustion is kept under close control by this arrangement; there is very little flame visible above the stack, and smoke emission is negligible.

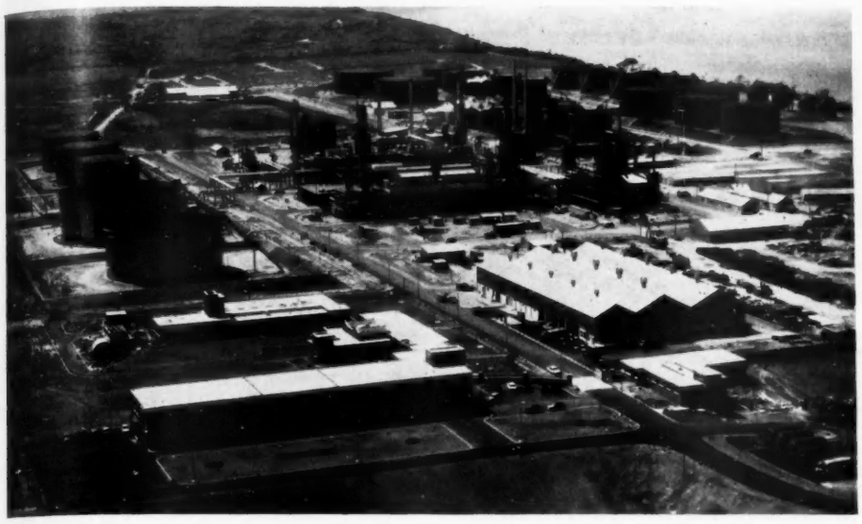
Process cooling is also unusual. Air-cooled finned tube heat exchangers are used in place of the water cooled type and the air circulation fans are mounted below the tube stacks. This arrangement has the great advantage that since no water is used, there is no possibility of polluted water escaping to the sea in the event of a pipe leakage. Some of the heat exchangers are equipped with automatically controlled louvres which restrict the air passage according to the process cooling requirements, control being direct, through relays from the process instruments.

Now that the refinery is in full operation some 300 workpeople are employed, about 50 of them being graduates of the National University of Ireland. The refinery is in an area which had no industry, and a considerable amount of incidental work was necessary. This included the erection of two overhead transmission lines bringing electricity at 110 kV, the laying of a water main from Ladysbridge, some 10 miles away, and the improvement of roads leading to the site. Eight houses have been built for key employees; the remainder travel by road from towns in the neighbourhood.

ELECTRICITY

No industry of any consequence can develop, or indeed survive, today, without an adequate and reliable source of electric power. This is the responsibility in Eire of the Electricity Supply Board, which was set up by the Government in 1927, and the Shannon hydroelectric scheme, brought into operation in 1929, was the first of many developments aimed at providing a country-wide supply network.

Lacking large supplies of coal, Ireland made



strenuous efforts to develop the other natural sources of power available, and today a considerable proportion of the country's electricity is generated by water power or by steam stations using turf fuel. The estimated water power potential of Irish rivers, excluding very small ones, is about 900 million units per annum, and the rivers already developed—the Shannon, Liffey, Erne, Lee, and Slady, account for 75 per cent of the total potential.

Turf is used in two ways, as hand or machine won sods, and in milled form. In the sod form it is burnt on chain grate stokers, and the steam raised is used in the normal way. A typical power station using this fuel is that at Portarlington (Co. Leix) which consumes the full output of machine won turf from the adjoining Clonsast bog. The turf, which has a moisture content of 18 to 45 per cent, and a net calorific value of 5,500 Btu per lb at 34 per cent moisture, is in sods of about 10 in long by 3 in square. It is mechanically handled into bunkers, and passes to a retort, where it is dried by preheated air before reaching the chain grate stoker. There are three boilers and two turbo-alternators, with an output of 12,500 kW each.

Ferbane generating station (Co. Offaly) uses milled turf; it is the largest power station using this fuel in Western Europe. The fuel used at Ferbane, which is burnt in the same way as pulverised coal, has a moisture content ranging from 40 to 60 per cent, and a calorific value of 3,370 Btu per lb at 55 per cent moisture. Its size ranges from dust up to ½ in. There are three boilers and three turbo-alternators, the station capacity being 60,000 kW.

Four smaller stations, on the west coast, where the industrial load is light, use hand won turf in sod form; each station has an output of 5,300 kW. In addition to the hydro-electric and turf fired stations there are coal and oil fired stations in several parts of the country, and there is a national distribution network of a very comprehensive nature.

The latest figures available (for the year ended 31 March, 1959) show that the total number of units generated was 1,895 million, an increase of 7 per cent on the previous year. Sharing of the load between the different power sources varies according to weather conditions, which naturally affect the amount of water available. For the period in question the power sources were used as follows:

Hydro	42·7 per cent
Sod turf	9·4 „ „
Milled turf	11·9 „ „
Native coal	1·1 „ „
Oil and imported coal ..	34·9 „ „

The Board maintains a sales organisation at its head office in Dublin, and the industrial power section of this department acts in a liaison capacity between the generation and distribution departments and the consumers, and takes part in the planning of a new industrial enterprise, or the extension of an existing one, from the beginning.

(Above) Ireland's first oil refinery, at Whitegate, Co. Cork, is now in full production. It uses air-cooling of the process units.

(Right) Typical of modern Irish industry is this aluminium strip and foil mill at Unidare Limited, near Dublin.

ENGINEERING MATERIALS

Many engineering raw materials which were formerly imported are now made, wholly or partly, in Ireland. Prominent is Irish Steel-holdings Limited, Haulbowline Island, Cobh, County Cork. Sponsored by the Government in 1947, Irish Steel took over a plant at Haulbowline from a firm which had gone into liquidation, and started the production of basic open hearth steel in the form of rolled products. Today the company has two open hearth furnaces, each of 40 tons capacity, and two rolling mills, an 18 in, three high, three stand roughing mill, and a 12 in, three high, five stand finishing mill. Steel is produced from 100 per cent indigenous scrap charges, uphill teemed into small ingots to suit the mill, and rolled into a wide range of rounds, squares, angles and flats. The requirements of various British Standards and other specifications are met. Irish Steel supply the total home demand within the range produced, and have achieved considerable success in the export market. A current contract is for 4,650 tons of deformed reinforcing bar for New Zealand. Galvanised flat and corrugated sheets are also produced from imported black coiled strip, and development plans include provision of plant for hot sheet rolling.

In a different product field the work of Unidare Limited, Finglas, Dublin, is an example of what has been done to develop products new to Ireland in a short time. Started just over ten years ago in a small way, Unidare now employ over 1,000 people at their Finglas works alone, and have subsidiaries elsewhere in the country.

The original Unidare product was electrical equipment, particularly transformers, which are still made, in a greatly extended range. From this product many others have developed. Today, the Unidare works, on a site of 60 acres, are really six separate production units, operating under a single management, and having products which are in many cases complementary. Steel, aluminium and copper wire and cables are produced, both for sale and for use within the organisation, wire netting and barbed wire are made, and a modern shell moulding foundry produces iron and non-ferrous castings. Welding electrodes, water pumps, electric storage and radiant heaters, plastics tubing and polythene sheet are all in regular production. One of the departments is operated by an associated company, Telecommunications Limited, for the manufacture of short wave equipment.

In their aluminium department, Unidare produce extrusions, foil, strip and wire, and operate a Properzi continuous casting and rolling mill for making aluminium rod. A considerable proportion of this rod is sold to other manufacturers, both in Ireland and overseas. This plant, a copy of one in Italy, casts aluminium bar continuously on the periphery of a water cooled copper wheel, and passes it directly to a 13 stand rolling mill, where it is reduced to ⅜ in round rod. Prominent features of this mill are its small size and the high quality of its products.

TRANSPORT

Within Ireland there are adequate transport facilities to meet the needs of industry. Trunk roads extend all over the country, and the Irish Transport Company (Coras Iompair Eireann) operates freight services by both rail and road. Dublin and Cork can both handle ocean going ships, and there are scheduled international air services from Dublin and Shannon.

Eire is preparing too, to enter the ship-building industry. Verolme Cork Dockyard Limited (an associate of the Verolme United Shipyards of Rotterdam) have taken over a small dockyard at Rushbrooke, Cobh, County Cork, where there is already a graving dock capable of taking 16,000 ton ships, and are developing a yard for shipbuilding as well as repairing. Stage one of the development programme, which is now in hand, involves the re-equipping of the engineering shops and the building of a slipway adjacent to the graving dock for building ships up to 33,000 tons.

There are many other industrial developments in hand in Eire, of which space does not permit mention, but there are several factors common to the whole picture, which the cross-section reviewed has revealed. Every facility is offered to industrialists by the Government, there is an adequate pool of labour, adaptable and willing to learn even entirely new trades, and the industrialisation of the country is backed by all the necessary facilities, including fuel, power, transport and accesibility to markets.

Flyover Built into London Road Junction

Since it was opened the Chiswick Flyover has been criticised for lacking elegance, being structurally old-fashioned, and taking too long to build. It is, however, probably the largest precast bridge yet built in this country. The project is described here in some detail.

The Chiswick flyover is a two-level road project about a half-mile long providing an overpass linking the Cromwell Road extension—London's new western approach—to the Great West Road, without interference from cross traffic. The through road is carried over a roundabout of 400 ft diameter, and having a 40 ft wide carriageway at the junction of the North Circular Road, Chiswick High Road, the road to Kew Bridge and the Great West Road. Traffic is distributed to these roads by four slip roads joining the roundabout to ground level. The road arrangement is shown in the plan below.

About 45,000 vehicles use the junction every day. Experience since the flyover has been opened shows that it has greatly relieved the congestion that was frequent before its construction.

The through road of the flyover has dual carriageways, 24 ft wide, separated by a central island, and each slip road is 24 ft wide for two traffic lanes. The gradient of each slip road east of the roundabout is about 1 in 20 and that of the through road west of the roundabout about 1 in 19. Other gradients do not exceed 1 in 40.

Though the flyover has been constructed over a period of 2½ years through a densely built-up area the demolition of buildings was kept to a minimum consistent with engineering requirements. Many miles of underground services, including telephone cables, TV and 66 kV cables, gas mains and a main sewer, have had to be deviated as the scheme progressed. So as not to impede the flow of traffic, the work was divided into stages. A temporary slip road on the south side of the works, connecting the Cromwell Road extension to Chiswick High Road, together with a temporary enlargement of the original roundabout were constructed first to provide additional capacity for the increasing traffic flow resulting from completion of sections of the Cromwell Road extension.

The flyover embodies two bridges: the main bridge consisting of four freely supported square spans each of 125 ft, with a width of 59 ft between parapets, carrying the through road over the new roundabout; and a bridge over Wellesley Road, east of the new roundabout, of 70 ft single skew span and 124 ft between parapets, to carry the slip roads and the through route where four 24 ft carriageways are required.

The approaches of the flyover and the section between the bridges are formed on embankments retained between mass concrete walls, faced with hand-finished bricks and with in-situ concrete copings forming guard verges 4 ft wide to both the through road and slip road carriageways. Altogether, 1,500,000 facing bricks have been used in the contract. The embankment filling consists of well graded mechanically stable gravel (hoggin) which was spread in 9 in layers and each layer compacted by nine passes of 8 ton smooth wheel rollers. Against bridge abutments and retaining walls, compaction was carried out using vibrating plate compactors.

Carriageway construction consists generally of a reinforced concrete base slab, 10 in thick, with a surfacing of 3½ in of hot rolled asphalt. Curing of the concrete proceeded under a sprayed bituminous emulsion skin. Transverse joints were formed in the base slab at a maximum spacing of 120 ft and a strip of light steel fabric was laid flat on the base slab over the joints before surfacing, as a precaution against possible cracking of the asphalt.

The parapet railing consists of tubular steel standards and rails connected by a mechanica joint. The small expansion gaps between rails and standards are fitted with neoprene expanded rubber washers. Road kerbing is of grey granite and lighting columns reinforced concrete of octagonal section.

All structures of the flyover have been designed to the Ministry of Transport Standard Highway Loading and for the 180 ton abnormal live load in accordance with British Standard 153 (1954). The design received the sanction of the Fine Arts Commission before work was begun.

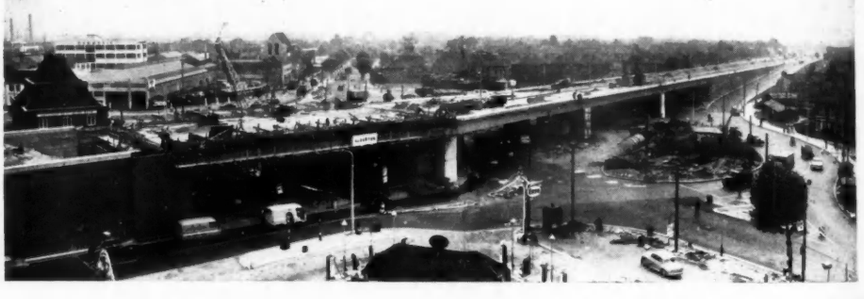
MAIN BRIDGE

The abutments and the two easterly piers of the main bridge are supported on reinforced concrete rafts founded on a stratum of compact gravel overlying the London clay. A narrow piled foundation has been laid to carry the western pier because of the proximity of a 48 in diameter sewer 20 ft below ground level. The piles, 10 in number, each 1 metre diameter and carrying a maximum load of 370 tons, were bored and cast in-situ to a depth of 80 ft below ground level, 60 ft being in the London clay.

The bridge abutments are of mass concrete, brick faced, and each pier consists of five massive concrete columns, lightly reinforced, and a heavily reinforced cap beam.

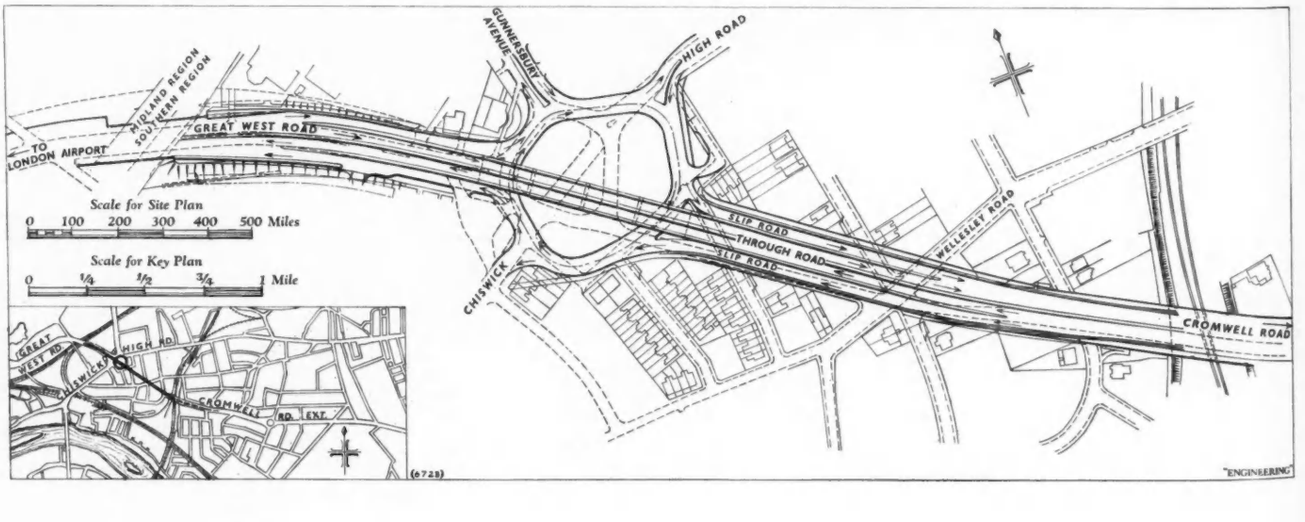
For each span the superstructure consists of 15 concrete beams side by side, each beam being precast in three sections. The end sections are about 38 ft long and the centre sections 48 ft long, each section weighing about 33 tons. The minimum 28 day cube strength of the concrete was 7,500 lb per sq. in. All beam units, which have both mild steel secondary reinforcement and prestressing cables post-tensioned by the Freyssinet system during manufacture, are of inverted T section with a narrow top flange and transverse diaphragms cast integral with the unit.

The outer beams of each span are of U section,



(Right) The flyover during the course of construction, showing the brick-faced approach ramps and the precast beam construction of the main bridge. Temporary traffic lanes were still in use when the photograph was taken.

(Below) Plan of the flyover site, indicating the extent of the demolition and the location in west London's road system.



made of concrete with grey Cornish granite aggregates, the exposed vertical face being lightly bush hammered.

The beams were specified to be cast within fully cladded buildings, where the necessary quality control of the concrete could be ensured at all times of the year. It was considered impracticable to cast the beams at the site owing to the congested conditions and they were manufactured in a factory 60 miles away, transported daily to the site where they were lifted by crane and erected directly on to the permanent bearings on the piers and abutments and on temporary rollers supported on steel trestles on either side of the transverse joints between the sections. All joints were filled with rapid hardening cement grout and each complete beam after assembly was post-tensioned by the Freyssinet system when the concrete in the joints had attained a cube strength of at least 6,000 lb per sq. in, usually 3 days after casting. Each duct contains a cable of 12 high tensile wires of 0·276 in diameter. The beams were stressed from one end with a load of 113,000 lb per cable and the ducts were afterwards pressure grouted with neat cement colloidal grout.

An in-situ reinforced concrete slab was cast at the level of the top of the beams and the deck prestressd transversely using the Gifford-Udall system with cables threaded through the webs and transverse diaphragms of the beams. The anchorages have been located in the inner webs of the outer U beams.

Fixed and rocker bearings are provided alternately on abutments and piers. The bearing plates and rockers are made of Meehanite CB metal, and the locating pins are of stainless steel. Expansion joints in the carriageways and verges above the "free end" bearings consist of stainless steel sliding plates.

RUBBER BEARINGS

The Wellesley Road bridge was constructed in two halves separated by a longitudinal joint. The abutments are of brick-faced mass concrete on reinforced concrete raft foundations.

The complete deck consists of 43 precast prestressed beams of inverted T section, post-tensioned by the Freyssinet system. These beams were also manufactured off site, and are 72 ft long, each weighing about 24 tons. They were placed side by side on the bearings and in-situ concrete transverse diaphragms cast between the beams and around metal ducts passing through the beam webs. The joints between the beam flanges were filled with concrete and an in-situ concrete deck cast at the level of the top of the beams. Each half of the deck was prestressed transversely by the Freyssinet system using 12-wire cables (0·276 in diameter wires) threaded through the transverse ducts.

Rubber bearings made by Andre Rubber Company have been adopted for this bridge. Each beam bears upon a rubber and steel bonded unit 16 in by 11 in by 7 in thick at the "free" end and upon a sheet rubber pad 16 in by 11 in by 1 in thick, reinforced with canvas, at the "fixed" end. The maximum dead load and reaction per beam is 32 tons and the live load reaction 28 tons. It was considered that the use of bonded rubber bearings was particularly applicable to this type of skew bridge as there is a tendency for expansion and contraction movements to occur in both longitudinal and transverse directions.

The outer edge beams are constructed of concrete with grey Cornish granite aggregates, lightly bush hammered on the exposed face.

The main contractors for the flyover were the Alderton Construction Company, Limited, London, SW1. All precast beam units were manufactured by the Cowley Concrete Company Limited; the sub-contractors for the bridge piling were Braithwaite Foundations and Construction Limited. The consulting engineers to the Ministry of Transport and Civil Aviation for the design and supervision of the project were Harry Brompton & Partners, Hobart House, London, SW1, and the consulting architect Mr. George Stewart.

Concrete Piles 140 ft long, Made with Collapsible Cores

For the 3,500 ft long jetty for the new Esso refinery at Milford Haven, John Mowlem are making hollow prestressed concrete piles up to 140 ft long on the long-line system, using collapsible cores. The piles are of 22 or 27½ in external diameter, have 3 in walls and weigh up to 18 tons; the prestressing wires are 0·276 in in diameter.

A 500 ft long casting bay has been laid down for making the piles. A steel casing, hinged along its back, forms the external shuttering. The internal shuttering consists of lightly stressed wires (2,000 lb per wire) at close pitch over which is wrapped tarred building paper; the core wires are kept in position by notched formers of steel at the ends of each pile and by weak-concrete "biscuits" along the length of the pile. As soon as the initial set has occurred the biscuits are broken out by pulling a "go-devil" through the pile and the core wires are released so that they can be withdrawn by tractor.

A very dry concrete (1 : 1 : 1½, developing 7,500 lb per sq. in at 28 days) is used for the piles and is fed into the mould through an entrance along the whole length of the top of external casing. Extensive use of vibrators and judicious employment of pokers (avoiding punching the paper) gets the concrete well packed round the wires, which are each prestressed by a load of 3·14 tons, and the standard mild steel helical reinforcement. The core is prevented from "floating" by wedges under the holding straps of the casing and by steel pins through the casing that are withdrawn before the concrete sets.

About 900 piles are being used in the jetty, of which more details will be given in a subsequent issue. The piles themselves have been designed as part of a structure that may have to take the side thrust resulting from wind loading on the side of an empty 100,000 ton tanker.

Tunnelling Record at Snowy Mountains

A world tunnelling record is claimed on behalf of an Australian firm working on the Snowy Mountains hydroelectric and irrigation scheme in south-eastern Australia. In one week a working face was advanced 500 ft; no details are given with the claim of the size of the tunnel or of the rock formations through which it is being driven, but the work is on the first leg of the nine-mile tunnel taking water from the Tooma river to the power station at the headwaters of the Tamut.

It is also reported that low-voltage electric "gates" are being fitted into the water tunnels of the scheme to prevent eels from getting into the Murray system where they might kill off the prized Murray cod.

Better Joints for Concrete Roads

An improved form of jointing for concrete roads has been patented under the name of the Fisher Joint. It is a flexible extrusion of rubber or synthetic polymers that is built into the pavement slab at the time of construction. It is claimed that the seal will remain intact through any normal concrete movements and provide a durable water seal without ever forming an above-surface protrusion.

The new jointing is marketed by Stuart B. Dickens Limited of 36 Victoria Street, London, SW1. Over 6,000 ft have so far been used in the new St. Albans bypass and more in the reinforced concrete marginal haunches along the London-Birmingham motorway.

4 in Module Reaches Australia

The Modular Society has been established in Australia. The inaugural meeting was held in Sydney on 22 September with the dean of the faculty of architecture at Sydney University as president. It is a year since the modular movement in the United States was reconstituted as the Modular Building Standards Association with similar aims as its United Kingdom counterpart. The 4 in module is now accepted in many English-speaking countries; in the metric countries the near-equivalent 10 cm module has been adopted.

Lecture Courses in Concrete

A comprehensive list of courses in all branches of concrete technology that are being given throughout the country during the coming winter is available from the Cement and Concrete Association, 52 Grosvenor Gardens, London, SW1. A brief syllabus, dates, times, place and fee is given in each case. A separate list gives colleges which provide City and Guilds courses for supervisory grades.

Hydroelectric Power in Siberia

It is reported from the USSR that a 6,000 MW hydroelectric power scheme is to be built at Yeniseisk. This is roughly three times the capacity of the station at Kuibyshev, the largest station yet in existence, and 1,000 MW larger than that planned for Krasnoyarsk, which is also on the River Yenisei. These sites are in central Siberia.

Building Centre Established in Manchester

The Manchester Building Centre has been formed with the support of the London Building Centre to which it is affiliated.

As in London, the Manchester centre will enable manufacturers of all kinds of building products to exhibit so that engineers, architects, builders and the general public can see in one place an up-to-date selection. There will also be an unbiased information service and suitable rooms for lectures and visiting exhibitions.

Correspondence is at present being dealt with by the director, Mr. John P. Griffiths, at a temporary office in the Department of Building, the College of Science and Technology, Sackville Street, Manchester 1.

Improvements to the Panama Canal

Large-scale excavation work is at present underway in the Panama Canal to widen the Gaillard Cut to a 500 ft channel throughout its 8 mile length. This will permit two-way traffic, even allowing for the increase in size of the tankers using the canal. It is hoped that the widening will be complete for about half the length of the cut by mid-1961; the remainder of the excavation will probably take another 4 years.

Other improvements to be made include the installation of fluorescent lighting along the banks of the cut and the purchase of faster "mules"—the locomotives used for towing ships through the locks.

Timber Paraboloids for a School

The roof of a new Ipswich school consists of 24 hyperbolic paraboloid timber shells, either 25 ft square or 20 ft by 25 ft long. The shells comprise two layers of tongued and grooved boarding; 5th quality European Redwood used in the upper layer and unsorted Redwood in the laminated edge beams has been treated with Celcure wood preservative; the under layer is of unsorted Redwood and untreated. Three layers of bitumen felt above ½ in insulation board on the upper surface and a clear varnish on the soffit complete the finishes.

The roofing subcontractors are Wheelers Limited, Sudbury, Suffolk.

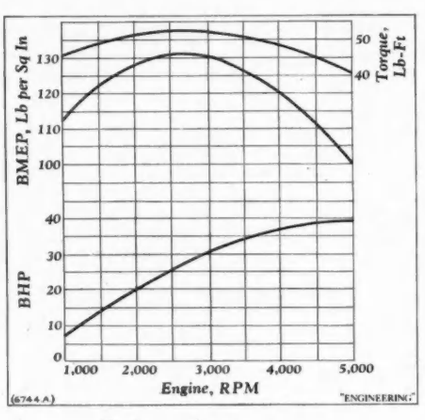
FORD ANGLIA

By Gordon Wilkins

Completely Revised with OHV Engine, Four-Speed Gearbox and New Body

The new Ford Anglia has a two-door body of unusual style, with backward-raked rear window, and a new overhead valve engine with a remarkable stroke-bore ratio of 0·6 to 1. The previous model, which with simplified equipment now becomes the Popular, has proved successful and its appearance has been much admired, but Ford never succeeded in obtaining a really low fuel consumption from it. The old 1,172 c.c. side valve engine was often blamed, but experiments have proved that it was not entirely the cause. The engine has been put into competitive cars and engines from other cars have been put into the Anglia, showing that the chief blame lay with the square-shaped body, which was exacting a penalty of up to 5 m.p.g. in fuel consumption compared with the shapes of competitive models like Volkswagen and Renault.

The new Anglia has therefore been given a more rounded nose, with falling bonnet line, but it does seem odd that the designers should have added cowls over the headlamps, which are notorious consumers of power. To obtain rear seat space and leg room superior to those on all competitive cars, the wheelbase has been lengthened, and the backward-raked rear window was adopted to give maximum rear headroom.



Engine performance curves.

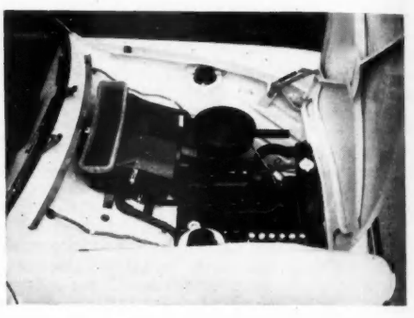
The unit structure is entirely new, and incorporates box section reinforcements built into the top of the rear wheel arches instead of the more usual straighter members running from seat pan into the trunk floor. It looks a simpler structure, but entails some encroachment into the luggage space, which is already reduced by the spare wheel placed squarely behind the rear seat backrest. However, the total volume available is said to be 10 cu. ft, as on the previous model. The new wheel arch construction has prevented the insertion of the fuel tank inside the rear wing and it now lies below the trunk floor.

Of the 350,000 old Anglias and Prefects that were made, about 70 per cent were two-door models and the proportion was rising with increasing sales in the USA. There will therefore be no four-door version of the new body, but the old Prefect, incorporating the new power unit and transmission, will continue. Apart from the obvious advantages of rigidity and lightness in the two-door construction, it is felt that the two doors 43 in wide give better access to rear seats than four narrow doors.

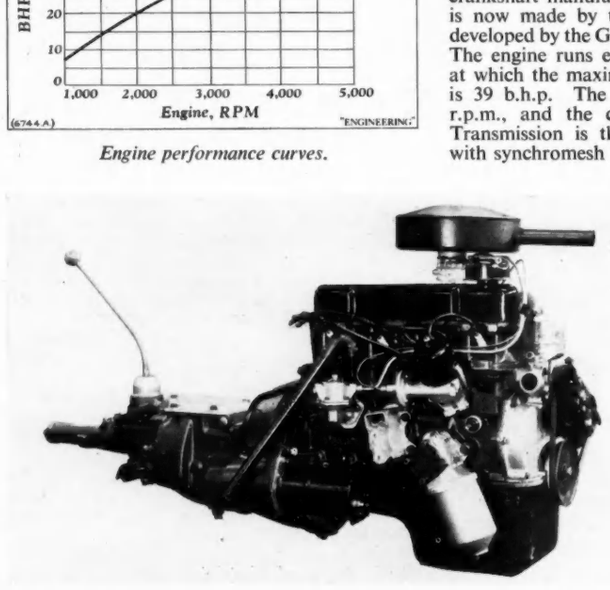
Suspension design is conventional, with the Macpherson spring struts at the front and asymmetrical four-leaf half elliptics with zinc interleaving at the rear. Periodicity of front and rear springs is approximately equal and although various types of independent rear suspension have been tried, it is claimed this system gives the best balance of handling and riding comfort.

The engine is an entirely new four-cylinder unit with bore and stroke of 80·96 × 48·4 mm (997 c.c.). This is such an unusual configuration that it suggests the way is being prepared for a second version, at some future date, a car with the same bore and a longer stroke, giving about 1·5 litres. However, in the present form it gives a low stiff engine (with blocks less than 7¼ in high) which fits well under the falling bonnet line. The short stroke also suits the new method of crankshaft manufacture. The hollow cast shaft is now made by the shell moulding technique developed by the German Ford works at Cologne. The engine runs easily up to over 5,000 r.p.m. at which the maximum power output (installed) is 39 b.h.p. The torque is 52·8 lb-ft at 2,700 r.p.m., and the compression ratio is 8·9 : 1. Transmission is through a four-speed gearbox with synchromesh on the three upper ratios.

The reverse-raked back window has several features: it gives more rear-passenger room (at the cost of a window shelf), it allows clear visibility in conditions of snow, frost and rain, and it prevents direct radiation from the sun into the rear.

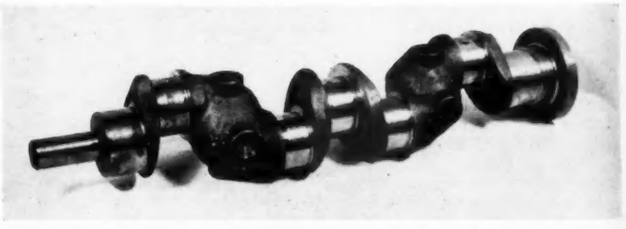


A fresh-air heater, incorporating demisters, is available as an extra. The air intake is situated immediately in front of the windscreen to eliminate engine fumes. The engine block is less than 7¼ in high and fits well under the sloping bonnet.



(*Left*) *Extreme stroke to bore proportions (80·96 mm × 48·4 mm) produce a low piston speed and give a good gas-pressure surface area. Separate inlet ports are used and the combustion chambers have a machined finish. The compression ratio is 8·9:1 and 39 b.h.p. is developed at 5,000 r.p.m.*

(*Below*) *By using a new shell moulding technique (developed by German Ford), a lightweight hollow crankshaft is produced.*



JAGUAR IMPROVEMENTS FOR 1960

Jaguar Cars Limited have announced much improved versions of their 2·4 and 3·4 litre models and a new 3·8 litre saloon. A 3·8 litre version of the XK150 will also be available. The entire 1960 range will incorporate a number of improved passenger and driver facilities.

Inadequate driver visibility has been one of the most common complaints about Jaguar saloons, particularly with regard to the width of the front pillars. However, this has now been well taken care of by the introduction of slim pillars, a semi wrap-around windscreen and an enlarged rear window area.

Layout of the instrument panel has been improved to give easier reading of the dials and better accessibility of the controls. A " safety-eye " has been fitted to the dashboard to warn the driver if the brake fluid drops below the danger level. Interior heating has been extended to the rear compartment. Door locks are now shielded.

Further details of the new Jaguar range will be given in ENGINEERING at a later date.

Heat Transfer at High Gas Pressures

Part Two

The introduction of nuclear power has created a need for research into boilers in which the critical Reynolds number is exceeded. This article describes work of this type done by Normalair Limited, Yeovil, Somerset.

OPEN CIRCUIT RIG

This is used to explore the effect of roughened surfaces on heat transfer at very high Reynolds numbers. In this arrangement the heat transfer is from the roughened surface into the air. During tests the pressure used was 100/120 lb per sq. in and the mass flows were variable up to something above 300 lb per minute. The first test specimens consisted of stainless steel tubes of 2 in o.d. heated by electric currents of up to 5,000 amps. The air was passed through the tube, the outside being lagged. The power input was single phase a.c. controlled by using one 39 kVA leg of each of three Foster variable 3-phase transformers feeding the primary of a secondary transformer with an output rating of 4 V, 5,000 A. The three secondaries of the secondary transformers were connected in series to the busbars feeding the heating current into the test specimen. Considerable analysis was necessary before a satisfactory busbar layout designed to keep down the inductance and to obtain the desired heating e.m.f. was achieved.

A range of roughening devices were tested including rings of different shapes and varying pitches inside the tubes. Thermocouple measurements of the tube temperature at $\frac{1}{4}$ in pitch longitudinally gave the complete temperature distribution of the tube showing all the cyclic variations caused by the rings, the positions of which were checked by X-ray photographs.

The same compressed air facilities were also used for calibrating the electrical resistance of the test specimens. For this work it was only necessary to pass air through the tubes at a number of steady temperatures and when the tube thermocouples reached uniformity to measure its resistance. From this data both the overall heat transfer coefficients of the roughened tubes and the local cyclic variations in heat transfer coefficient between the rings were calculated.

A further test section is in the design stage comprising a bundle of small electrically-heated stainless steel rods inside a tube simulating a fuel rod bundle. In such a fuel bundle the heating of the rods will be far from uniform, both axially and radially, and as designed, the heating of the individual rods will be controlled in accordance with a predetermined pattern and a novel system of longitudinal temperature distribution control has been developed in order to simulate the temperature distribution along a core channel.

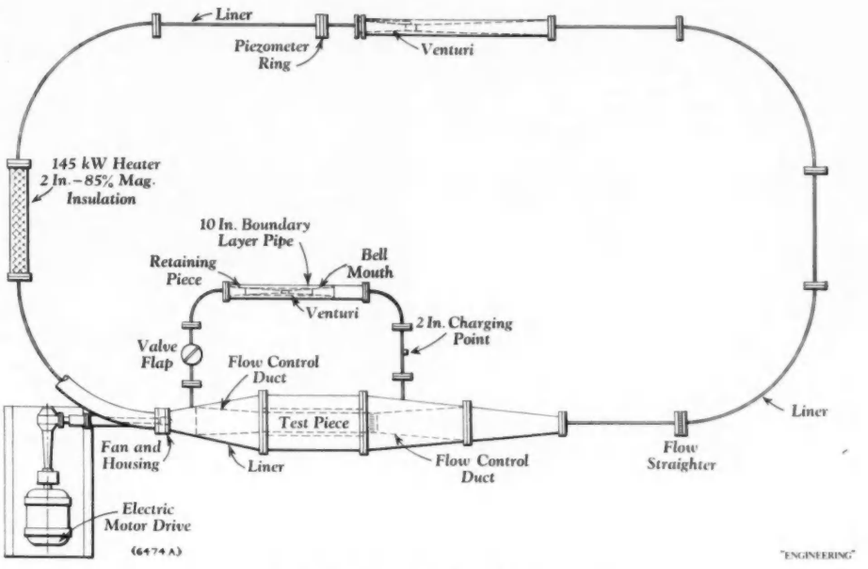


Fig. 3 Diagram of closed circuit rig.

CLOSED CIRCUIT RIG

This is designed primarily for testing boiler tube banks over a complete range of gas flows up to about 190,000 lb per sq. ft per hr minimum cross-section. Fig. 3 shows the circuit, which is unique in several respects.

(*a*) The high pressure casing has an internal layer of light weight low heat capacity insulation approximately 1 in thick with a smooth aluminium internal liner. The effect of this is that any change in the heat input is reflected almost instantaneously in the gas temperature. The testing of a range of conditions is greatly speeded up, there being no waiting time required for conditions to stabilise. Eventually this aluminium insulation will be replaced by stainless steel and the top operating temperature increased.

(*b*) The by-pass circuit. The boundary layer air in front of the test bank is extracted and returned to the circuit downstream of the working section. A number of temperature traverses of the air in front of the test bank have been made and although the recording gear is sensitive to 0·1° C, at no time has any variation in temperature been detected across the face of the tube bank. This is quite different to previous experience on aircraft component heat transfer rigs without boundary layer extraction, where the temperature variations across the face of the heat exchanger were often very large.

(*c*) On any boiler tube bank, which may be 20 or more rows deep, it is known that the first and last rows do not contribute their full share of heat transfer. A number of test specimens of varying geometrics have been built and tested. In each specimen the heat transfer is measured individually on each tube. Curves are plotted showing the variation in heat transfer from front to back over the longest test banks of 14 rows or 7 cycles of staggered tubes, these can be extrapolated to give the overall coefficient for any depth of tube bank.

(*d*) To date it has been impracticable to measure the air/water heat transfer coefficient under water conditions equivalent to an actual boiler. For ease of measurement the water velocities in the rig have been kept low and a separate rig built to determine the water side heat transfer coefficient under identical water flow conditions. From tests results on the two

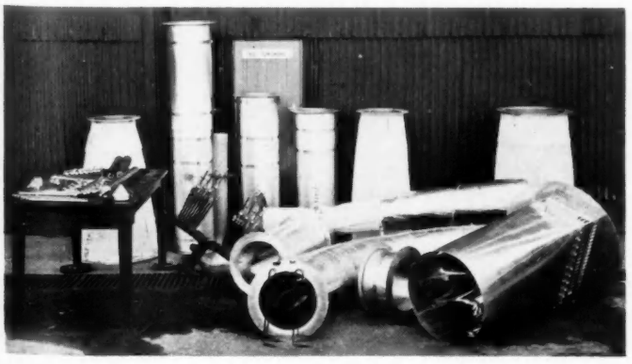


Fig. 4 Components, insulation liners, manifolding fan, shaft and rotor of closed circuit rig.

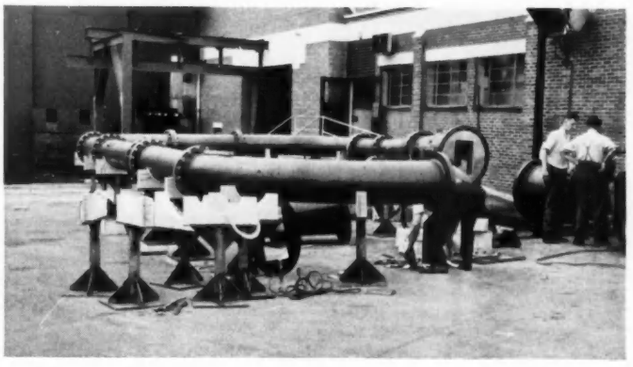


Fig. 5 Erection of closed circuit rig, showing working section joint and internal insulation.

rigs the air-side heat transfer coefficient is deduced. This is the figure required by the boiler designer who usually already has data on the water-side coefficient corresponding to his design water conditions.

Fig. 3 shows the internal liners in various stages of covering with the light internal insulation. In front of one of the bends are shown two of the 108 electric heating elements each of 1·35 kW loading. The round to rectangular taper section shows the slots for extracting the boundary layer. These slots are also visible in Fig. 5, which shows the rig partly completed. On the corner of the table in Fig. 4 is the 13 in diameter 2-bladed fan. The blades are untwisted, of constant 1·8 in chord, RAF 6 section, for ease of machining and made from tool steel. The pitch is low, 15½°, so that they cannot be stalled whatever the resistance of the circuit. The theoretical efficiency is 78 per cent. The blades are inclined forward 1½° so that the centrifugal loading approximately balances the thrust loading at maximum rig pressure conditions.

Also in Fig. 4 is shown a water inlet manifold. In the first test bank the water tubes were taken through glands in the main pressure casing. In subsequent test banks the test assembly was built onto a ring inserted between two of the flanges and the water connections and instrument leads were taken out radially through glands in this ring. This is shown in Fig. 6 A corresponding distance piece was inserted on the far side of the loop.

Any bank of tubes can be tested which can be accommodated within the 30 in diameter × 42 in length of the high pressure casing of the test piece. The first series tested were on a single pitch dimension of staggered tubes using a rectangular cross-section of 20¾ in × 13½ in. This is three tube pitch cycles in width and lengths have been of 5 cycles and 7 cycles. The tube pitch centres are on overlapping or staggered 4½ in squares. With both lengths of tube bank the water flows and temperature rises have been measured individually for three rows of tubes front to back, 15 or 21 tubes depending on the length of the test section. Similar rates of water flow and heat transfer have also been maintained in the 1½ rows of tubes either side of the three measured rows. The rows of ½ tubes are actually full tubes so far as the water flow is concerned but the air side fins are slotted and fitted with sealing plates in planes through the axes of these side tubes. Thus so far as the tubes on which measurements are taken are concerned, the air flow conditions should be almost the same as if the test bank extended to infinity on either side.

The operative length of each tube in the test banks was only 20¾ in with the result that a normal rate of water circulation through it the temperature rise of the water would be very small and difficult to measure accurately. The water flow rate was adjusted to give temperature rises of the order of 5° C which can be measured to an acuracy of about 3 per cent. In the first test bank selected sensitive glass thermometers were used in pockets in the water lines outside the high pressure casing while in subsequent banks thermocouples have been used the leads passing through radial glands in the additional flange ring on which the bank was assembled.

The water circulation system is original and very easy to adjust being most stable in operation. The principle on which it works is, everywhere, constant head gravity tanks feeding the inlets to constant speed centrifugal pumps. In each main there are two valves, one used for on/off purposes only and the other fitted with a pointer for adjustment. A cold main from the factory water cooling system feeds a gravity tank through an adjustable valve and the overflow from this tank is pumped back into the mains cooling system together with the overtank from the test circuit. This cold gravity tank feeds the required amount of cold water into a mixing tank in the test circuit, which is again a gravity tank feeding the main circulating pump and overflowing at a constant level into the return tank from which the water is pumped back into the mains cooling system.

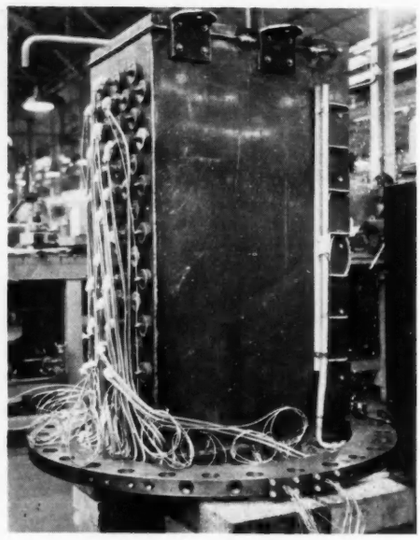


Fig. 6 Typical test section showing thermocouple connection.

The outlets from 16 tubes at a time can be coupled through flexible tubes to pipes fixed to a bar which can be rotated through a small angle. Under normal conditions the 16 pipes discharge into a flat tank of large surface area which then feeds into the mixing tank. When the flow rates are to be measured the bar is rotated and causes the 16 pipes to discharge into drums for a suitable length of time. During this measuring time the level in the flat tank falls by 3 or 4 in, insufficient to alter the flow and hence temperature in the mixing tank by any appreciable amount. The drums are weighed before and after each check and their contents then tipped back into the circuit. The results of these flow measurements show that apart from small changes due to the circuit temperature the flow through each tube is for all practical purposes constant. The maximum variation from the mean in the flow through any of the tubes was under 4 per cent, the majority being within about 1 per cent of the mean.

The gas heating system comprises a nest of 108 nickel sheathed resistance elements each of 1·35 kW, total 146 kW, switched in groups and individually on a 3-phase circuit. This heating power is barely sufficient for some of the larger test banks. Unfortunately it represented the maximum load which could be put on the mains during normal working hours at the time the rig was designed. The heating elements have given no trouble and all the glands in the pressure casing have proved reliable but certain precautions are necessary. This type of heating element is extremely susceptible to damp and if water once gets inside the nickel sheath it is extremely difficult to dry it out. When first commissioned the insulation resistance was low The heating elements were connected to a power supply of about 4 volts for some days until the insulation became reasonable when the voltage was gradually stepped up to 12 volts. Permanent external heaters of 3 kW were then installed underneath the heating section of the rig and these proved sufficient to keep the section dry. The 3-phase mains were then connected to the switchboard.

Under running conditions the gas temperature in the rig seldom exceeds 150° C. The rig is suitable for temperatures up to 250° C but except at very low rates of mass flow the heat transfer to the test bank is too large to permit higher temperatures to be obtained with the heating power available. This in no way seriously reduces the value of the rig. The temperature differences between the gas and the water are quite sufficient for accurate measurement.

The present method used to drive the rig is far from ideal but the rig was designed and built extremely rapidly to provide heat transfer data for a projected design of a boiler for the Atomic Energy Authority Advanced Gas-cooled Reactor (AGR) and only the materials and motive power available could be used. The drawings were not commenced until July 1, 1958, and the first report giving preliminary test results was typed on 29 August, 1958. Since that date a great deal of time has been spent in improving the accuracy of the rig and in developing the technique of rapid interchangeability of test banks. No alterations have been necessary to the fundamental design of the circuit which has worked exceptionally well. The modifications have been mainly to mechanical details of the drive and measuring techniques and particularly to the auxiliary rig used for measuring the water side heat transfer coefficient.

TYPICAL RESULTS FOR CLOSED CIRCUIT RIG

In Fig. 7 the preliminary results from four test sections are plotted together with the calculated Sieder-Tate line for the banks. This is a convenient form of display for correlation purposes.

The four test sections contained banks of 2⅛ in root diameter finned mild steel tubes having fins $\frac{5}{16}$ in high. Two different bank geometries were used and two of the sections incorporated baffles. The gas side heat transfer coefficients, both the mean value for the bank and the separate values for the tubes throughout the bank, were evaluated for various mass velocities ranging from 20,000 to 110,000 lb per sq. in per hour, at a maximum rig pressure of over 200 lb per sq. in. Pressure drop figures across and through the tank were also obtained.

Equivalent diameter D_e as in Jameson's correlation (Jameson, S. L., pp. 633-642, *Trans. A.S.M.E.*, vol. 67, 1945):

$$D_e = \frac{2\ (\text{Fin area} + \text{bare tube area})}{\pi\ (\text{Projected area})}$$

Air mass velocity G based on minimum flow area for the tube pitching in the bank.

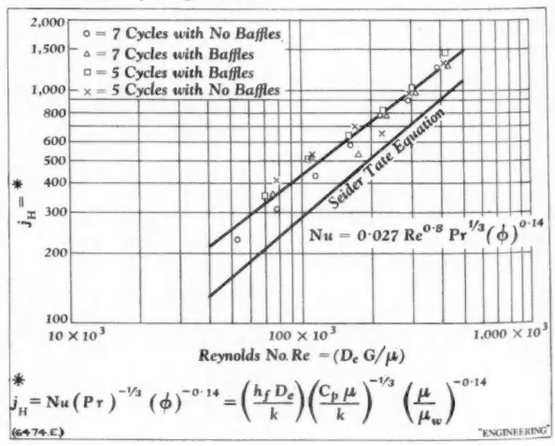


Fig. 7 Generalised data for tubes.

ANALOGUE FOR ENGINEERING RESEARCH

Network Analyser May be Used for Many Problems

A variable frequency network analyser, capable of simulating a wide variety of engineering systems, has been developed by the Electrical Research Association, Leatherhead, Surrey. Costing some £70,000 to build and taking five years to develop, this electrical network analyser (ENA) represents the most advanced equipment of its type in Great Britain. Although primarily intended for the solution of problems connected with electrical power transmission it is eminently suitable as an analogue device in many other branches of engineering.

The unique feature of this particular analyser is its frequency range, which is continuously variable from 159·2 to 15,920 c/s. This enables frequency responses to be plotted and resonances to be located much more easily than with a fixed frequency device. Furthermore, transient phenomena can be closely studied without recourse to laborious step-by-step methods. Not only can a wide range of measurements be made but highly complex networks, with up to 18 generators, can be simulated.

The equipment has been designed with a particular regard to accuracy. No component has a tolerance value greater than plus or minus 1 per cent and connecting leads are said to introduce errors of less than 0·1 per cent. Steady state measurements are made by servo-balanced a.c. bridges which give a direct indication of all the measured quantities. This system has a resolution of 0·1 per cent of the base quantity.

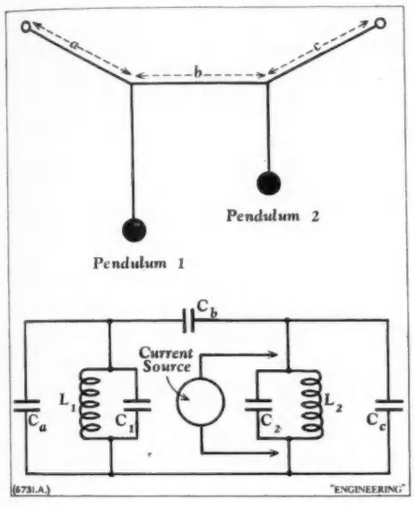
The ERA network analyser, like most others is mainly intended for use in the study of power, systems, where it has an exceptionally wide range of application. In addition to simulating and measuring the flow of active and reactive power, busbar voltages, effects of quadrature boosters, effects of altering generator ratings, etc., behaviour under disturbed conditions can be equally well studied. Common problems of this sort include finding fault levels for breaker specification, the transient stability of generators after faults, fault currents and voltages for protective gear design, the effects of neutral earthing and mutual coupling.

Studies are not limited to system frequency effects since the analyser has been built for use over a wide range of frequencies. In consequence it is well suited to investigating the flow of harmonics in a system. In addition to steady state measurements, transient phenomena may also be analysed, in fact ENA has been used to investigate the propagation of lightning surges in a substation and the waveform following faults on a system with neutral earthing inductors.

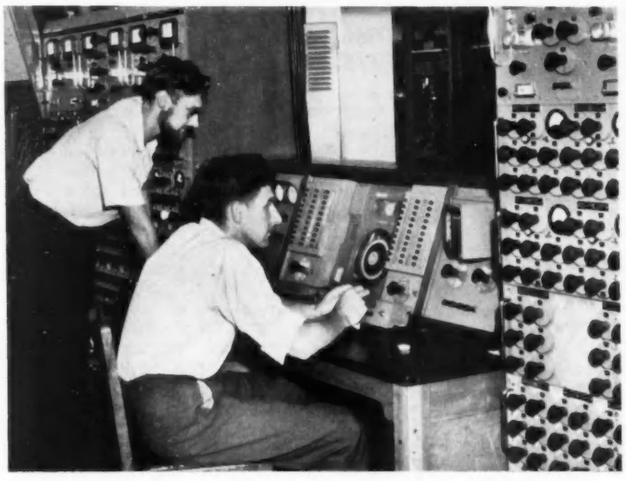
The facility with which this device can be used to solve complex power system problems may be extended to many other electrical networks. It may also be used to study thermal, mechanical and electromechanical problems. Thermal analogues are made up from the resistance and capacitance elements of ENA. The distributed system is then simulated by a large number of these lumped electrical components to obtain a good approximation to the thermal conditions.

To demonstrate one of the non-electrical applications of this device, the ERA have constructed a model of a complex pendulum system, showing how mechanical vibrations may be studied. A simple simulated two pendulum system, shown in Fig. 1, has been constructed and checked against the real thing to show the accuracy of the analogue. For practical working the analyser would be capable of simulating a system with 35 vibrating components.

The potentialities of ENA as a research, development and design tool in many branches of engineering have been fully recognised by the Electrical Research Association who have decided to make their facilities available to non-members of the Association at commercially competitive rates. For members the cost will be £30 per day, for non-members with problems that come within the scope of ERA's research experience the cost will be £40 per day. If the analyser is required for the solution of entirely new problems where experience has not yet been gained, the cost will be higher, but the aim will still be to keep it down to a competitive level (a typical charge for the use of a top class digital computer is £50 per hour, which does not include the development of the programme).



(Left) A two-pendulum vibratory system can be simulated by an equivalent electrical circuit.



(Right) ENA, the first variable frequency electrical network analysser to be built in Britain, has many potentialities as a too for research and development.

Concluding **Heat Transfer at High Gas Temperatures**

It is of importance to be able to obtain from the test data generalised non-dimensional relationships, and to correlate these with subsequent test data and other published information. The following paragraphs describe briefly the preliminary correlation.

The simplest non-dimensional relationship for heat transfer inside and outside tubes is of the form

$$Nu = c\,Re^{x}\,Pr^{y}$$

where

Nu = Nussels Number $\frac{h\,D}{k}$

h = gas side heat transfer coefficient (per unit area)

D = tube diameter (or equivalent diameter)

k = thermal conductivity of the fluid

Re = Reynolds Number $\frac{G\,D}{\mu}$

G = mass velocity

μ = viscosity of the fluid

Pr = Prandt Number $\frac{C\mu}{k}$

C = specific heat of the fluid (at constant volume if a gas).

The Sieder-Tate equation is a well-established relationship against which to measure the test data. It has the form

$$\frac{h\,D}{k} = 0{\cdot}027\left(\frac{D\,G}{\mu}\right)^{0{\cdot}8}\left(\frac{C\,\mu}{k}\right)^{\frac{1}{3}}\left(\frac{\mu_b}{\mu_w}\right)^{0{\cdot}14}$$

or

$$Nu = 0{\cdot}027\,Re^{0{\cdot}8}\,Pr^{\frac{1}{3}}\,(\phi)^{0{\cdot}14} \quad . \quad (1)$$

where μ_b μ_w are the fluid viscosities at the bulk and surface temperatures respectively.

Fig. 7 is a graph of j_H against Re, where

$$j_H = Nu\,Pr^{-\frac{1}{3}}\,\phi^{-0{\cdot}14}$$

The Sieder-Tate line and the results from the tests on the four test sections are plotted on these axes.

The least-squares line for the test points has been calculated, leading to the general relation for the tests

$$Nu = 0{\cdot}063\,Re^{0{\cdot}767}\,Pr^{\frac{1}{3}}\,(\phi)^{0{\cdot}14} \quad . \quad (2)$$

In the above equations the diameter used is equivalent diameter as defined in Fig. 7.

It can be seen that the slopes of the two lines are almost identical and the test results are all well above the Sieder-Tate line. The correlation is a useful one and confirmed the predicted performance.

The work described in this article was co-ordinated by a committee under the chairmanship of Sir Harold Hartley. The members of the committee are Dr. A. W. Still and Messrs. D. R. C. Guttery, C. H. Secord, T. P. de Paravicini and M. Turner.

The work was carried out by Normalair Limited at Yeovil, Somerset, as part of the research programme of John Brown Land Boilers Limited. Other John Brown companies, notably Constructors John Brown and the Special Engineering and Nuclear Division, have also been interested.

MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

BIRMINGHAM
"The National Inspection Council for Electrical Installation Contracting," by E. W. Roper. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Wed., 14 Oct., 7.30 p.m.
CARDIFF
"Measuring Instruments," by H. W. A. Smith. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 13 Oct., 7.30 p.m.
CHESTER
"Silicones and Their Application in Industry," by D. R. Goddard. Chester Branch. Westminster Hotel, City Road, Chester. Tues., 13 Oct., 7.45 p.m.

British Institution of Radio Engineers

LONDON
"Use of Transistors in Communication and Control," by E. Wolfendale. Students' Meeting. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 14 Oct., 6.30 p.m.*
NEWCASTLE UPON TYNE
"True Motion Radar," by A. Harrison. North Eastern Section. Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 14 Oct., 6 p.m.

Chemical Society

LONDON
Niels Bjerrum Memorial Lecture by Professor E. A. Guggenheim. Presentation of the Dexter Award in the History of Chemistry. Thurs., 15 Oct., 7.30 p.m.

Combustion Engineering Association

SHEFFIELD
Brains Trust Meeting on "Furnace Operation." Northern Region. Grand Hotel, Sheffield. Tues., 13 Oct., 10.30 a.m.*

Diesel Engineers and Users Association

LONDON
Annual General Meeting. "Bearings for Diesel Engines," by P. P. Love. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 15 Oct., 2 p.m.

Illuminating Engineering Society

LONDON
"The Nature of Light," by Sir Lawrence Bragg. Royal Institution, Albemarle Street, W1. Thurs., 15 Oct., 6 p.m.

Institute of Marine Engineers

LONDON
"Centrifugal Purification of Oils," by M. E. O'K. Trowbridge. Tues., 13 Oct., 5.30 p.m.*
GLASGOW
"The Survey of Marine Machinery," by G. J. Thomas. Scottish Section. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 14 Oct., 7.30 p.m.

Institute of Marine Engineers and Institution of Naval Architects

SOUTHAMPTON
"Train and Car Ferries," by J. B. Campbell. Southern Joint Branch. Technical College, St. Mary Street, Southampton. Wed., 14 Oct., 7.30 p.m.

Institute of Metal Finishing

LONDON
"Some Notes on American Organic Finishing Practice," by W. Stein and A. A. B. Harvey. Organic Finishing Group. British Institute of Management, 80 Fetter Lane, EC4. Wed., 14 Oct., 6.30 p.m.

Institute of Road Transport Engineers

LONDON
Annual General Meeting and Film Display. Metropolitan Area. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 15 Oct., 6.30 p.m.
EXETER
Discussion on "Sif Bronze and Its Action." South Western Group. Headquarters of the City Fire Brigade, Exeter. Thurs., 15 Oct., 7.30 p.m.
GUILDFORD
"Problems in Developing the High-Speed Diesel Engine," by B. W. Millington. Southern Centre. Wooden Bridge Hotel, Guildford, Surrey. Wed., 14 Oct., 7.30 p.m.
LEEDS
Discussion on "Brake Testing." Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 15 Oct., 7.30 p.m.
LIVERPOOL
"Design of Radial-Flow Turbochargers and Their Application to Road Transport," by E. Kellett. West Regional Centre. Liverpool Architectural Society, Bluecoat Chambers, School Lane, Liverpool 1. Mon., 12 Oct., 7.30 p.m.

Institution of Civil Engineers

LONDON
Symposium on "Asphalt-Surfaced and Concrete Pavements for Airports," comprising: "The Requirements for Airfield Pavement Surfaces," by G. S. Cooper; "Asphalt Surfacing for Airfields," by A. W. Attwooll and D. C. Broome; and "The Suitability of Concrete for Airfield Runways," by A. W. Hill. Tues., 13 Oct., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "Is the Present Pace of Electrical Progress Good for the Community?" opened by the President, Sir Willis Jackson. Mon., 12 Oct., 5.30 p.m.*
Chairman's Address on "The Relationship of Physical Mechanisms to Psychological Processes," by Professor A. Tustin. Measurement and Control Section. Tues., 13 Oct., 5.30 p.m.*
Discussion on "Graduate Training in Industry," opened by W. H. Taylor. Education Discussion Circle. Wed., 14 Oct., 6 p.m.*
Chairman's Address on "The Electrical Engineer and the Heavy Chemical Industry," by T. E. Houghton. Utilization Section. Thurs., 15 Oct., 5.30 p.m.
BELFAST
Chairman's Address on "The Provision of Commercial Television in Northern Ireland," by T. S. Wylie. Northern Ireland Centre. David Keir Building, Queen's University, Stranmillis Road, Belfast. Tues., 13 Oct., 6.30 p.m.
CARDIFF
Chairman's Address by H. Jackson. Western Centre. South Wales Institute of Engineers, Park Place, Cardiff. Mon., 12 Oct., 6 p.m.*
CATTERICK
"Subscriber Trunk Dialling," by D. A. Barron. North Midland Centre. HQ Mess, School of Signals, Catterick Camp, Yorkshire. Tues., 13 Oct., 6.15 p.m.*
MALVERN
"The Basic Physics of Thermonuclear Processes," by D. R. Chick. South Midland Centre. Winter Gardens, Malvern. Mon., 12 Oct., 7 p.m.
NEWCASTLE UPON TYNE
Chairman's Address by H. Watson-Jones. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 12 Oct., 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE UPON TYNE
Discussion on "Planning a Modern Power Station." Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne 1. Mon., 12 Oct., 7.15 p.m.

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Recent Developments in Ventilation Practice," by F. R. L. White. Birmingham Branch. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Tues., 13 Oct., 6.30 p.m.
LEEDS
"New Developments in Heating Control," by A. C. Fox. Yorkshire Branch. Griffin Hotel, Leeds. Wed., 14 Oct., 7.30 p.m.

Institution of Mechanical Engineers

LONDON
Address on "The Engineer, Life and Diesel Engines," by the President of the Institution, H. Desmond Carter. Wed., 14 Oct., 6 p.m.*
"Interior Space Problems in Vehicle Design," by B. C. Mills. London Graduates' Section. Tues., 13 Oct., 6.30 p.m.*
BIRMINGHAM
"Machine Tool Development in the USSR," by N. Stubbs. Midland Branch. James Watt Memorial Institute, Great Charles Street, Birmingham. Thurs., 15 Oct., 6 p.m.
COVENTRY
"Construction and Behaviour Characteristics of Tyres," by T. French. Coventry AD Centre. Hotel Leofric, Coventry. Tues., 13 Oct., 7.15 p.m.
LUTON
"Problems We Meet," by L. H. Dawtrey, chairman of the Automobile Division. Luton AD Centre. Royal Hotel, Mill Street, Luton. Wed., 14 Oct., 7.30 p.m.
PETERBOROUGH
"Adhesives as Applied to Engineering Methods," by A. Bramley. East Midlands Branch. Offices of the Central Electricity Generating Board, Albert Meadows, Peterborough. Tues., 20 Oct., 7 p.m.

Institution of Plant Engineers

BLACKBURN
"Operational Research in the Steel Industry," by G. D. Jordan. Blackburn Branch. Castle Hotel, Blackburn. Thurs., 15 Oct., 7.30 p.m.
BRISTOL
Discussion on "Acoustics Insulation and Its Thermal Properties." Western Branch. Grand Hotel, Broad Street, Bristol. Wed., 14 Oct., 7.15 p.m.
DUNDEE
"Experience of Training Young Engineers for Marine Service," by J. P. Bruce. Dundee Branch. Taypark Hotel, West Ferry, Dundee. Wed., 14 Oct., 7.30 p.m.
GLASGOW
"The Engineer's Approach to Non-Destructive Testing of Metals," by H. Potter. Glasgow Branch. 425-427 Sauchiehall Street, Glasgow. Thurs., 15 Oct., 7.15 p.m.
MANCHESTER
"New Developments in the Paint Industry," by A. Warmsley and Dr. A. I. Seavall. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 13 Oct., 7.15 p.m.
NOTTINGHAM
"Jodrell Bank Radio Telescope," by C. N. Kington. East Midlands Branch. County Hotel, Theatre Square, Nottingham. Wed., 14 Oct., 7 p.m.

Institution of Production Engineers

LONDON
"Properties and Application of Modern Precision Grinding Wheels," by J. Manning. London Graduate Section. Tues., 13 Oct., 7.15 p.m.
BRISTOL
"Human Relations in Industry," by R. A. Banks. Engineering Faculty, The University, Bristol. Mon., 12 Oct., 6.30 p.m. (Tickets are required.)
DERBY
"What's New in Casting," by A. Short. Derby Section. St. James's Restaurant, St. James's Street, Derby. Mon., 19 Oct., 7 p.m.
PETERBOROUGH
Open Discussion Meeting. Peterborough Section. Peterscourt, Peterborough. Wed., 14 Oct., 7.30 p.m.

Institution of Structural Engineers

GLASGOW
Chairman's Address by Hugh Fraser. Scottish Branch. Institution of Engineers and Shipbuilders in Scotland 39 Elmbank Crescent, Glasgow, C2. Mon., 12 Oct., 7 p.m.
LEEDS
Chairman's Address by Dr. E. Lightfoot. Yorkshire Branch. Hotel Metropole, Leeds. Wed., 14 Oct., 6.30 p.m.
SHEFFIELD
Chairman's Address by Dr. E. Lightfoot. Yorkshire Branch. Royal Victoria Hotel, Sheffield. Thurs., 15 Oct., 6.30 p.m.

Iron and Steel Institute

LONDON
Joint Meeting with the Corrosion Group of the Society of Chemical Industry on "Corrosion." 14 Belgrave Square, SW1. Thurs., 15 Oct., 2 p.m.

Junior Institution of Engineers

LONDON
"Programming a Computer," by A. C. Quarterman. Fri., 16 Oct., 7 p.m.*
SHEFFIELD
Annual General Meeting. Chairman's Address by G. E. Taylor. Sheffield Section. Livesey Clegg House, 44 Union Street, Sheffield 1. Mon., 12 Oct., 7.30 p.m.

Liverpool Metallurgical Society

LIVERPOOL
Presidential Address on "The Production and Use of Steel Wire and Steel Wire Ropes," by B. Ryan. Department of Metallurgy, University of Liverpool, 146 Brownlow Hill, Liverpool 3. Thurs., 15 Oct., 7 p.m.

Royal Statistical Society

BRISTOL
"Ways of Measuring Uncertainty," by Professor G. A. Barnard. Bristol Group. Library Room, University of Bristol, Bristol 8. Thurs., 15 Oct., 5.45 p.m.*
NEWCASTLE UPON TYNE
"Fractional Factorial Experimental Designs," by G. A. Coutie. North Eastern Group. The Percy Building, King's College, Newcastle upon Tyne. Wed., 14 Oct., 7 p.m.

Society of Chemical Industry

LONDON
"Engineering Aspects of Recent Research Projects in the Preservation of Fish," by G. C. Eddie and S. Forbes Pearson. Joint Meeting of the Chemical Engineering Group and the Food Group. Tues., 13 Oct., 6 p.m.*
"Fretting Corrosion," by Dr. K. H. R. Wright. Corrosion Group. Wed., 14 Oct., 6 p.m.*
Joint Meeting with the Iron and Steel Institute on "Corrosion." Thurs., 15 Oct., 2 p.m.

Society of Instrument Technology

LONDON
"An Automatic Analogue Computer for Missile Homing Investigations," by J. G. Thomason. Data Processing Section. Manson House, 26 Portland Place, W1. Wed., 14 Oct., 7 p.m.*
LIVERPOOL
Discussion on "pH." Liverpool Section. MANWEB Industrial Development Centre, Paradise Street, Liverpool. Thurs., 15 Oct., 7.15 p.m.
MANCHESTER
"Instrumentation in the Textile Industry," by L. H. C. Tippett. Manchester Section. Central Library, St. Peter's Square, Manchester 1. Tues., 13 Oct., 6.45 p.m.
MIDDLESBROUGH
"An Ultrasonic Flowmeter," by R. E. Fischbacher. Tees-Side Section. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. Thurs., 15 Oct., 7.30 p.m.
NOTTINGHAM
"The Atomic Clock," by Dr. L. Essen. East Midland Section. The University, University Park, Nottingham. Thurs., 15 Oct., 7.15 p.m.*

West of Scotland Iron and Steel Institute

GLASGOW
Presidential Address by J. W. Todd. Fri., 23 Oct., 6.45 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor at least three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metal Finishing. Apply to 11A Gloucester Road, London, SW7. (KNIghtsbridge 9181)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Naval Architects, 10 Upper Belgrave Street, London, SW1. (SLOane 4622)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Iron and Steel Institute, 4 Grosvenor Gardens, London, SW1. (SLOane 0061)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Liverpool Metallurgical Society, Greenhithe, Grosvenor Road, St. Helens, Lancs. (St. Helens 5879)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgrave 3681)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
West of Scotland Iron and Steel Institute, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)

On the Shelf

By Frank H. Smith

A useful reading list comes from the city librarian of Leeds. Entitled " Work Study and Operational Research " it is sub-titled " A list of books, pamphlets and periodical articles available in the Library of Commerce, Science and Technology " and is dated May, 1959. Although I tend to view anything north of Marble Arch as foreign country I have a tremendous respect for anything born of those large libraries with names like Manchester, Liverpool, Birmingham, Leeds, and so on (if your name's not here, assume it is in " so on ") and if I see their librarians at Aslib " do's " I stand afar and gaze at them with awe and respect even if they are not smoking cigars. Anyway, the list is divided into work study and operational research, divided again into books and pamphlets and periodical references (i.e., two divisions).

I am delighted to see that the first number of *The Annals of Occupational Hygiene* (Pergamon, 4-5 Fitzroy Square, London, W1) at £3 10*s* per volume is devoted to the noise menace. Whether it is because I read more about it in the Press or because I am getting older I do not know, but it seems to me that it's getting WORSE.

The Non-Destructive Testing Society of Great Britain has its headquarters at The Firs, Stebbing, Nr. Dunmow, and the first number of its *British Journal of Non-Destructive Testing* appeared in July. Five shillings may seem a lot for 14 pages of text but presumably the journal is included in the membership fee, which is only two guineas.

Sotheran (2 to 5 Sackville Street, London, W1 —one of those streets that does not muck about with odds and evens) have a catalogue (926) of " sets and runs of periodicals and publications of learned societies " going at reduced prices.

The autumn list of Cambridge University Press is a neat little booklet (in Cambridge blue) which contains, *inter alia*, an announcement of the reissue of six CUP items as paperbacks. But these are the more expensive paperbacks in the half-guinea to 15*s* range. An interesting forthcoming item is the second volume of G. I. Taylor's papers. A card to Bentley House, 200 Euston Road, London, NW1, will no doubt bring you a copy of the list.

The latest number of the *Aslib Proceedings* has a double number—8 and 9—to overcome the confusion of the printers' *affaire*. I say *has* a double number because one cannot say it *is* a double number. It is the usual size but covers a particularly interesting subject—the May Conference on the " Presentation and Interpretation of Technical Information."

Lots of people have already mentioned this while I was on holiday but in case you missed it, the US Bureau of Standards has issued a supplementary list of its publications, 1 July, 1957, to 30 June, 1959. This includes instructions on how to buy the things but the whole shooting match is a supplement to National Bureau of Standards Circular 460 ($1·25) and its Supplement ($1·50) and I suggest you try HMSO if you want them. I am still wondering why a supplement should cost more than its parent.

On a hot Friday afternoon I was reading casually through the list of Government publications for May and got to the Ministry of Defence section. Specification DEF-1188 Hooks, Bill, and Slashers, seemed feasible, and so did the next half-dozen dealing with Shears, Garden, and a few different types of Screwdriver, but then, stap me if I did not read DEF-1211 Cots, Dropside, Wood. What on earth does the Ministry of Defence want with Cots, Dropside, Wood? Can it be that they store the things for five years and then sell them at a loss from some remote place in the Midlands so that Government Surplus Stores can flog them to the public? Or can they possibly be intended for those babies that the various Services are left holding?

MANUAL DYNAMICS

Work Measurement. By VIRGIL H. ROTROFF. *Reinhold Management Science Series. Reinhold Publishing Corporation, 430 Park Avenue, New York 22 NY, USA;* and *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (39*s*)

This book, one in the Reinhold Management Science Series, concerns a very controversial subject of industrial engineering of great interest to management. It is intended for practising managers and those who aspire to management, and consequently must be judged on different grounds to established textbooks such as Barnes's *Motion and Time Study*.

Work measurement is necessary for any efficient planning and control of work and its techniques stem from F. W. Taylor. This book introduces what it is convenient to call stop-watch-rating time study following conventional practice and uses as illustration engineering machine shop examples. The preparation and use of standard work times is explained and then the setting up of various wage incentive schemes using standard times. Short chapters are devoted to method study, costing, the consultant's role and labour relations.

From the foreword, preface and style adopted, this book is intended for managers, among others, who have no previous acquaintance with the potentially explosive techniques of time study. It is unfortunate therefore that so much space has been devoted to superfluous details (for managers) of working out a straightforward time study when this is already detailed in so many textbooks, and yet no mention is made of the controversies on rating and fatigue allowances that exist. It is most important for any manager that he should be acquainted with these potential trouble spots especially if he wishes to introduce time study into a factory or office for the first time. The training of engineers in rating and the subsequent control of rating standards is most important for any management, but this is not stressed. Fatigue allowances are found from a chart which is new to this reviewer but which does not help in support of any claim that time study is scientific. The techniques of memo-motion (time lapse photography) and ratio delay are not mentioned, yet curiously enough in this context micromotion photography is, although the two former techniques are frequently practised in the United Kingdom, but the latter is not known to be practised by anybody except research workers today. Much work, especially where more than two machines are operated by one worker, cannot adequately be dealt with using the techniques discussed yet the economics of machine interference (based on time-study data) should be explained to all managers nowadays when automatic controls are becoming increasingly common.

The chapter on the cost aspect is competently set out and it is noted that indirect labour costs offer opportunities for cost reduction using work measurement, a point often overlooked. An aspect not mentioned, however, is that today, especially in the process industries, the cost of direct and indirect labour can be a small proportion of the factory cost, the important factor being plant utilisation. This poses many difficult questions for the manager interested in using work measurement linked to wage incentive schemes.

The index provided is clear and adequate for the book but no bibliography is given and this, in a text intended to bring a new subject into focus, is a serious defect. The views of trade unions, managements, industrial engineers and research workers on time study are abundantly documented now and should be read by anybody new to the subject; in such a book an introduction to the intensive bibliography of the subject available both in the United States and Great Britain is essential.

The author is an American consultant and therefore for a British reader the implicit linking of work measurement and wage incentive schemes is rather dangerous as a different outlook prevails in some industries here. There are many cultural differences in industry both between USA and Britain and between industries and districts in Britain itself. This book does not treat the difficulties faced by management in a welfare state with some trades and industries newborn since the war and some centuries old. A consultant here is forced to.

The reviewer found himself in the difficult position of discovering nothing new in this small book for British readers which was not already adequately dealt with in British Institute of Management publications specifically for British readership at much less cost.

J. A. C. WILLIAMS

TETRODE OF TRANSISTORS

Junction Transistor Electronics. By RICHARD B. HURLEY. *John Wiley and Sons Incorporated, 440 Fourth Avenue, New York 16, NY, USA;* and *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (100*s*)

Transistor Electronics. By ARTHUR W. LO, RICHARD O. ENDRES, JAKOB ZAWELS, FRED D. WALDHAUER and CHUNG-CHIH CHENG. *Macmillan and Company Limited, St. Martin's Street, London, WC2.* (45*s*)

Fundamentals of Transistors. By LEONARD M. KRUGMAN. Revised Second Edition. *John F. Rider Incorporated, 116 West 14th Street, New York 11, NY, USA;* and *Chapman and Hall Limited, 37 Essex Street, London, WC2.* (25*s*)

Principles of Transistor Circuits. By S. W. AMOS. Published for *Wireless World* by *Iliffe and Sons Limited, Dorset House, Stamford Street, London, SE1;* and *John F. Rider Incorporated, 116 West 14th Street, New York 11, NY, USA.* (21*s*)

At the International Convention on Transistors and Associated Semiconductor Devices held at Earl's Court in May this year some 150 technical papers and lectures were presented covering all aspects of transistor design and applications (see ENGINEERING, 5 June '59, p. 741), the great majority of them being original contributions to our knowledge of these devices. Next week at the National Electronics Conference in Chicago, many papers will be devoted to the same subjects. This interest is a measure of the intensity of present day research and development in the field of transistors. The time has come for taking stock of the vast accumulation of material published on the transistor since it was first announced in 1948, and this is the reason for the spate of textbooks now appearing. The four works just published divide very neatly into two pairs; the first, consisting of *Junction Transistor Electronics* and *Transistor Electronics*, both by American authors, are of distinctly advanced level and are intended to meet the needs of post-graduate students and design engineers, while the second pair, *Fundamentals of Transistors* (the second edition of an American book originally published in 1954), and *Principles of Transistor Circuits*, by a member of the BBC's engineering training department, have been written expressly for the technician and amateur constructor.

The parallelism between the first two books is so close that one is tempted to ask whether some form of consultation between publishers would not have been feasible. Not only do the content and presentation show a striking similarity, but even the choice of title represents a duplication. *Transistor Electronics*, though apparently broader than its companion, also gives pride of place to the junction transistor since, apart from very

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recent developments, transistors other than the junction type (for example the point-contact and field-effect varieties) are either obsolescent or used only in special-circuit devices.

As was the case with the thermionic valve, the engineer concerned with the design of circuits employing transistors need possess a knowledge only of their electrical circuit parameters, or " black-box " characteristics, as one author puts it, but to exploit the potentialities of this intriguing device to the full, he should have a deeper knowledge of its underlying physical principles. The authors of both *Transistor Electronics* and *Junction Transistor Electronics* have therefore wisely devoted an entire chapter to a discussion of the solid-state physics of the transistor.

Neither book attempts to cover the manufacture or testing of transistors and therefore cannot serve as a handbook or general reference work on the device. Their emphasis is strictly on the transistor as a circuit element and its applications. The authors generally refrain from drawing too close parallels with the thermionic valve, as this tends to obscure possibilities of circuit applications peculiar to the transistor. Both books discuss at considerable length the equivalent circuit of the transistor, this in itself being a controversial subject and open to a number of different approaches or " philosophies," the word so cheerfully misused in America.

The use of the transistor in low and high frequency and power amplifiers is accorded separate chapters in each book, and both books provide an exhaustive treatment of transistor oscillators and the use of the transistor in modulation and de-modulation. The application of the transistor in non-regenerative switching (pulse) circuits as described in *Junction Transistor Electronics* should offer a valuable introduction to the study of electronic computer circuits, *Transistor Electronics*, however, gives a useful, but more general, treatment of pulse circuits.

In place of bibliographies at the ends of chapters, the latter book gives sets of problems, whereas its companion volume presents fairly extensive bibliographies which apart from a very occasional reference to British work (none at all to Continental) are derived entirely from American sources—perhaps this is foregiveable since the transistor was after all an American discovery. Both books are very well produced and can be recommended for their balanced and lucid accounts of the subject.

Principles of Transistor Circuits is altogether a more elementary treatment and assumes no previous knowledge of the subject. Emphasis is again placed on applications, but introductory chapters consider in simple fashion the physical fundamentals and circuit parameters of the transistor. The theory is clearly set out, knowledge only of elementary mathematics being assumed. Many worked examples are given, but to quote the equations and then to repeat them with substitution of numerical values followed by the resultant simple arithmetic seems very wasteful of space and to play down even to the dimmest of students.

Chapters are devoted to the design of transistor amplifiers (both small-signal and large-signal) and transistor oscillators, leading up to the design of a circuit for a transistor superheterodyne receiver; this coverage is not attempted in any of the other three books. The omission of literature references and of suggestions for more advanced reading is regrettable in a work of this type, for they form one of the more attractive features of its American counterpart which otherwise covers much the same ground. The condensed style and cramped layout of *Fundamentals of Transistors* may make it less inviting to British readers but the student who works systematically through the book will, undoubtedly gain a more thorough knowledge of the subject. The work of revision has led to the inclusion of brief but useful accounts of more recent devices such as the " surface barrier transistor," the transistor tetrode, and the spacistor. The book will serve as a useful preparatory course to *Transistor Electronics*, particularly as the chapters on amplifiers and oscillators are based on lectures delivered by two of the authors of the larger work.

G. N. J. BECK

NUCLEAR BINDING FORCES

Comparative Study of Atomic Legislation in Europe. By K. WOLFF and F. SCHMID. *European Nuclear Energy Agency, OEEC 38 Boulevard Suchet, Paris, 16e, France.*

Apart from its intrinsic usefulness for those concerned with legislation, research, administration, or safety in the field of atomic energy, this study enables a comparison to be made of the degree to which different countries that are members of the Organisation for European Economic Cooperation have made progress in establishing atomic energy industries. All countries have found it necessary not only to pass special legislation governing the acquisition and use of nuclear fuel, but also to establish bodies to advise and assist research and development. So far, however, only Germany and Switzerland have thought it necessary to introduce special legislation covering third party liability on similar lines to that recently enacted in this country in the Nuclear Installation (Licensing and Insurance) Act. Although France is obviously the leading Continental nuclear power, the provision of such legislation may be regarded as some measure of the extent to which each country expects to be operating power reactors in the near future.

Active research bodies have been established by government or semi-public bodies in Belgium, France, Germany, Italy, the Netherlands, Norway and Sweden. In France there is a National Institute of Nuclear Science and Technology which provides highly specialised teaching in nuclear science and technology and issues diplomas conferring special doctorates.

Six of these countries are members of Euratom and subject to the provisions of its treaty governing the acquisition and use of fissile materials as well as the exchange of information. They are all members of the International Atomic Energy Agency and the European Nuclear Energy Agency. In addition, all countries have made some bilateral agreements with other countries, either for the exchange of information or for the supply of reactors and fuel.

The list of these bilateral agreements makes depressing reading for those who once hoped that this country would play the leading part in the development of peaceful uses for atomic energy in the world. While Austria, Denmark, France, Germany, Greece, Iceland, Italy, Norway, Portugal, Spain, Sweden and Turkey have agreements with the United States on research or power reactors, only Italy, and possibly Portugal, have made agreements covering those practical applications with the United Kingdom. More encouraging is the recent agreement between Britain and various OEEC countries including Euratom to proceed with project Dragon which provides for the construction and development of a high-temperature gas-cooled reactor at Winfrith Heath in Dorset. This proposal presumably supersedes an earlier agreement for cooperation in the design and development of the homogeneous aqueous suspension reactor which existed between the Reactor Centrum Nederland and the United Kingdom Atomic Energy Authority. The Netherlands is closely associated with Norway in Nuclear Energy Research. It appears as if most European countries are not anxious to enter on the production of power from atomic sources until they are satisfied that the plants offered are both reliable and economic. As with aircraft, foreign orders for nuclear power plants will only follow their successful operation in their country of origin.

LEGISLATOR

The Reviewers

Mr. J. A. C. Williams is principal of the College of Aeronautical and Automobile Engineering, Chelsea. From 1954 to 1955 he was a research fellow in the Department of Aircraft Production and Economics at the College of Aeronautics, Cranfield, and in 1956 served with National Coal Board as a headquarters work-study engineer. He is a B.Sc in psychology, an M.Sc. in occupational psychology, an A.M.I.Mech.E., an A.F.R.Ae.S., an A.M.I.Prod.E., an A.B.Ps.S., an F.S.S., and a member of the Ergonomics Research Society.

Mr. G. N. J. Beck, B.Sc., A.M.I.E.E., A.Inst.P., is employed by Imperial Chemical Industries Limited and serves on the editorial staff of *Endeavour* (foreign editions). From 1937 to 1945 he worked in the research laboratories of the General Electric Company Limited at Wembley and subsequently as assistant editor of *Electrical Engineering Abstracts*. He joined ICI in 1956.

Legislator has been for many years a Member of Parliament, well known for his interest in technical and industrial matters, and was again a candidate in the election. He has the rare distinction of combining Parliamentary duties with associate membership of the Institution of Mechanical Engineers, and has pronounced views on administration and legislation in the advancing areas of science and engineering.

NEW BOOKS

Performance and Efficiency Tests Exhaust Steam Injector British Railways Standard Class 9F 2-Cyl. 2-10-0 Freight Locomotive. Bulletin No. 13. *British Transport Commission, Room 268, 222 Marylebone Road, London, NW1.* (10s)

A foolscap size report dealing with a powerful freight locomotive of 1953 considerably more powerful than any previous type. The Bulletin is " concerned with the design as it emerged . . . and also forms the basis for allocation to duties for which they are best suited . . . within the most economical range." It is " expected to be the last class of steam locomotive to be built for the railways of Great Britain." So much for this progress.

Modern Copying Techniques for the Drawing Office. Symposium held at Hatfield Technical College, on 27 January, 1959. *Hertfordshire County Council Technical Library Service, Hatfield Technical College, Roe Green, Hatfield, Herts.* (6s)

Three papers—" Drawing Reproduction Techniques using a 1 : 1 Ratio " by H. Easterbrook and R. A Dixey of Standard Telephone, " 35 mm, 70 mm and Half-Plate Film Recording in the Drawing Office," by E. J. Aslin of Photostat, and " Practical Methods of Producing a Photographically Reproducible Drawing," by W. H. Barrett of Bristol Aircraft, and all under the chairmanship of H. R. Verry of HM Treasury. 32 illustrations. Such an array of talent would find difficulty in going wrong at 6s for 51 pages.

Bibliography of Monolingual Scientific and Technical Glossaries. Vol. II: Miscellaneous Sources. By EUGEN WÜSTER. *United Nations Educational, Scientific and Cultural Organisation, 19 Avenue Kleber, Paris XVI, France.* (12s 6d)

Volume II Miscellaneous means privately published as opposed to Volume I (1955) which contained standard glossaries. 1,043 items represent 26 langauges. It is difficult to understand what is meant by privately published when one of the first items seen is Uvarov and Chapman's " A Dictionary of Science " (Penguin, 1954). The guide is in order of UDC and the numbers used are indicated at the beginning, followed by a table of languages which is followed by a list of abbreviations and symbols. After the bibliography proper (pp. 23-77) come a subject index, a language index and an author index.

The History of Wagon-Lits, 1875-1955. By GEORGE BEHREND. *Modern Transport Publishing Company Limited, Russell Court, 3-16 Woburn Place, London, WC1.* (3s 6d)

A most readable though (because?) unofficial history of the most romantic railway organisation in the world. Traces the history from its foundation by a man named Nagelmackers and concludes with a table of types of sleeping cars in service 1959. The 32 pages leave one wishing there were more.

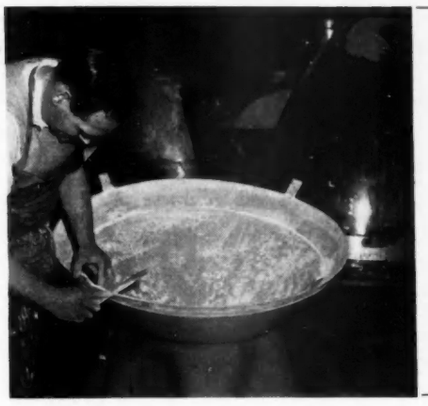
Polyester Fibres Reinforce New Plastics

Synthetic fibres are being used to reinforce plastics in place of glass. The product is less rigid but has improved abrasion and acid resistance. Use of an overlay containing the fibres appears best of all.

To the person who is prepared to accept reinforced plastics as an engineering material, there is another question which may well be asked, namely, " is glass fibre the best material for the reinforcement?" This is especially poignant to the engineer who has tried the material, and has seen it fail when used in contact with acids or under abrasive conditions. The answer to this in so many words, is that glass is certainly not the only reinforcement which can be used, and under conditions such as those mentioned, there is an improvement in performance when synthetic fibres are used either for the whole reinforcement or in an overlay. Some strength and rigidity, however, are sacrificed. Following actual use of several varieties of synthetic fibre in industry, Imperial Chemical Industries, the makers of the polyester variety called Terylene, have evaluated the relative performances of glass and polyester reinforcements.

Before consideration of these results it is worth looking for the mechanisms of failure. There is no reason for discounting the original postulates: firstly, in the absence of a really impermeable surface layer of resin, water or acid penetrates into the body of the plastic along the glass fibres—an action known as " wicking"; secondly, under abrasive conditions, glass fibres in the surface become powdered and act as a grinding medium for further damage. The obvious solution to this appears to be the provision of a surface coating of pure resin, which would also improve appearance. Such is in fact used, and is known as the gel coat, but even this is not immune from trouble. The other alternative is to seek for a replacement for glass, and hence comes entry of the synthetic fibre. Polyesters, in particular seem immune from wicking, and the product of wear is non-abrasive. Moreover, the desirable condition of the reinforcement's having higher strength and modulus than the surrounding resin is still maintained with such fibres, for the process of heat stretching them into filament gives them high strength and modulus. In their role of a strengthener they are therefore similar to glass fibres.

The results of tests in sulphuric acid, on materials incorporating such fibres, are shown below; there are also those obtained under abrasive conditions. In all cases the resin was Crystic 189 which is a cold-setting polyester resin made by Scott, Bader and Company. The scatter reflects the lack of reproducibility



Making the Comet IV radome.

Advantages over glass reinforcement are:
- Better acid resistance
- High impact strength
- Improved abrasion resistance
- Better electrical properties

Suggested end-uses are:
- Chemical plant where conditions are severe
- Electrical laminates, and crash helmets and similar applications needing high impact strength
- Overlays on main glass reinforcement to give chemical and abrasion resistance
- Translucent sheeting
- Boat hulls and vehicle bodies

obtained when reinforced plastics are made by hand lay-up. However, if there is a discernable trend, it is surely that the Terylene fabric overlay is beneficial. This holds good, moreover, in the abrasion tests performed both dry and after immersion in acid.

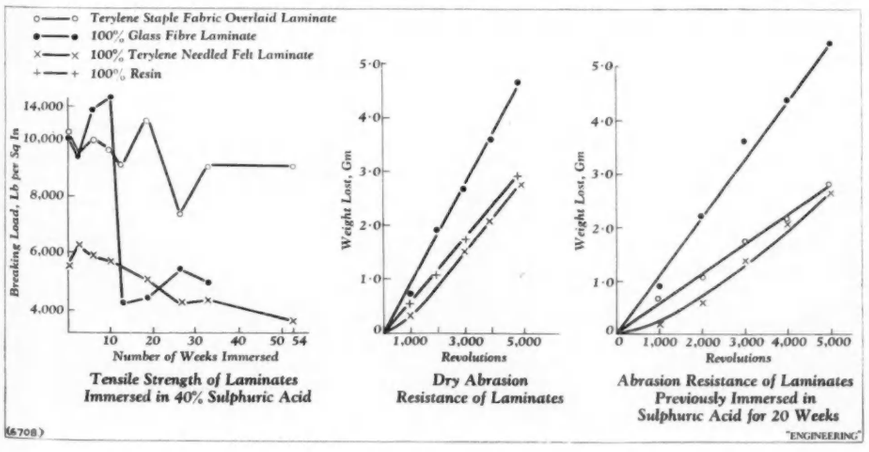
In the key to the curves it is seen that two types of reinforcement are referred to, containing a staple fabric and a needled felt. These are two of the possible forms; reinforcements are, in fact, made either of staple or filament, and can be woven, knitted, non-woven or needled mat. If non-woven, they may further be unbonded, or bonded with one of a number of adhesives which may or may not be soluble in the reinforced resin. This may appear to be unduly complicating the issue, but the form of the reinforcement has a great effect on the properties of the finished laminate: a needled-felt reinforced laminate, for example, is just as unsatisfactory in acid as is the one with glass fibre. While this is immediately annoying and partly unexplainable, it does mean that there is the equal possibility of finding a perfect combination of basic material and overlay reinforcement in the future.

Comparable laminates made with Terylene and glass cloth fabric reinforcement have shown the following properties: in tensile strength—19,500 compared with 35,000 to 55,000 lb per sq. in; and in modulus in bending—$0{\cdot}66 \times 10^6$ compared with $1{\cdot}38 \times 10^6$ lb per sq. in. The lower modulus is almost certainly responsible for the futher attraction of the synthetic reinforcement, namely, high impact resistance.

The uses which may be made of polyester fibre reinforcement—with advantage—are summarised in the box. Arising from the improved acid resistance—polyesters are not good in alkalies, incidentally—Mendip (Chemical Engineering) have used it in items of chemical engineering plant. One of these is illustrated below. It is a casing of a diaphragm pump, which was built in cast iron, but given a surface overlay of Terylene/polyester for better abrasion resistance. After five months satisfactory service, mechanical damage occurred to the overlay, and catastrophic erosion took place of the cast iron. The condition shown was reached after 20 hours. That the overlay stood up to the environment of powdered coke suspended in a mixture of 10 per cent sulphuric acid and manganese sulphate at 90° C, is well illustrated by the presence, after five months, of brush marks on the gel coat. Cast iron, remember, is usually considered to be abrasion resistant. Mendip are also using it in overlays for reinforced plastics water boxes which they are developing together with the Central Electricity Generating Board for power station condensers.

The good electrical properties of Terylene suit it for use as an insulation material and as reinforcement for electrical resins. In tests it has been found that the dielectric properties and power loss factors of such materials remain constant during changes in humidity and even after immersion in water. The Comet IV has radomes reinforced with Terylene polyester fibre and their manufacture is illustrated above.

Even at this early stage in the incorporation of synthetic fibres in plastics, there is evidence to show that new, better properties are being produced thereby, and this in turn should help reinforced plastics to prove themselves reliable engineering materials.



Rapid corrosion of underlying cast iron followed damage to Terylene/polyester overlay on acid pump casing.

GERMAN RELEASE AGENTS

In the heat of August it was announced that four previously unknown release agents which answer to the name "Lusin" had come over from Germany. Their object was to release resin and plastics components from their moulds. Moreover, the manufacturers, Lange and Seidel, of Nuernberg, had appointed as sole UK agents the London firm of Charles H. Windschuegl, 1, Leadenhall Street, EC3. The four agents comprise Lusin KE10, a universal mould release agent, KE195 for glass clear mouldings and phenolic resins, KE200 for polyesters and epoxy resins, and KE400 for the separation of reinforced plastics manufactured under conditions of heat and pressure.

The first of these is described as being "of particular interest" as its use does not hamper subsequent overprinting, spraying, metallising or polishing. It is an oil with an ignition point of over 325° C and can be applied by brush, cotton waste or spray. Water will effect removal from mouldings. The other three are blended compounds of metallic salts in an inert solvent mixture. They are normally brushed on to form a film which remains unbroken even after several pressings.

SPIN DRYER USES PLASTICS

If ever there was justification for using the word "revolutionary," it exists for that domestic appliance—the spin dryer. This, then, is the main character in this little rigmarole. Gordon-Miller Limited, of Croydon, Surrey, are the makers, and their particular variety is interesting because it is new, and because it incorporates several plastics mouldings.

The top of the dryer is moulded in one piece in grey Rigidex, which is the brand of high density

The lid is in polystyrene, the top surround in polyethylene.

polyethylene made by British Resin Products. This surround is proof against steam, boiling water and detergents and will not chip or corrode.

The lid assembly is also a single moulding, only a different material—Styron 475 high impact polystyrene. This plastic is made by the same company and was chosen because of its toughness, rigidity and dimensional stability, essential to this component because it has to make an effective seal on to the polyethylene top. For both components the moulders were Kingston Mouldings.

SYNTHETIC LATEX PLANT

Towards the end of their first year of bulk production at their Hythe, Southampton, plant, the International Synthetic Rubber Company, announces that work has started on a new plant to produce general purpose synthetic rubber latex. The new plant has been designed to produce 2½ million gallons of rubber latex a year for use in foam rubber articles, in carpet backing, adhesive paper, upholstery and other industries.

The International Synthetic Rubber Company's plant, see ENGINEERING, 1959, vol. 187, p. 25, was opened less than a year ago and was Britain's first venture in the bulk manufacture of general purpose synthetic rubber. The plant has a capacity of 70,000 tons a year and makes the United Kingdom independent of overseas sources of this material.

Already this company has exported synthetic rubber to many overseas markets, including Australia, South Africa, Norway, Sweden and Europe.

NEW THERMOPLASTIC

Polypenco Limited of Welwyn Garden City announce that they have added a new thermoplastic to their range. It is known as K51 and is a chlorinated polyether. While having a heat distortion temperature similar to that of nylon 66, it can be subjected to continuous operating temperatures of 120-130° C in an oxidising atmosphere. Its strength of 6,000 lb per sq. in Rockwell hardness of R100, and inertness to almost all alkalies, solvents, chlorides, and inorganic acids, makes the material attractive for bearings, valve seats, seals, gaskets, washers and impellers which have to operate under severe corrosive conditions.

The new material comes in a wide range of extruded shapes which can be readily machined.

RATPROOF CABLES

A number of disturbing observations have been made in Sweden during work to find to what extent rats are responsible for electric cable failures. Females, being found more voracious than male rates, were left in a cage with 16 different cord and cable samples. After two days only two samples covered with steel and aluminium remained intact.

The rats—admittedly albinos—were well fed, so what damage hungry rats would do is an unpleasant thought: a diet of unplasticised pvc and nylon cord, garnished with aluminium seems attractive to them.

Several ideas occurred to the research workers—from the Swedish cable firm of Sieverts Kabelverk and the Royal Veterinary College of Stockholm. Firstly, the rat repellent: samples were prepared with commercial repellents, and several other likely compounds. None had the desired effect, except a complex of cyclohexylamine and zinc dimethyldithiocarbamate, which showed promise. Next the workers tried winding the cables with fine and coarse emery cloth. Even these, however, were still torn to bits; presumably the rats chewed on their gums when their teeth were worn out.

The investigators conclude that rats, being playful and inquisitive animals, attack materials which have no function as food, or which can be used as teeth sharpeners. No soft rubber or plastic materials are likely to resist attack, and at present only cables with metal sheathing other than lead will give full protection. They end with a challenge to the chemical industry to develop *the* rat repellent for the job.

RARE EARTH METALS

Successful production of all the rare earth metals has now been achieved by Johnson Matthey and Company Limited, of Hatton Garden, London, EC1. The rare earth elements comprise 15 elements from lanthanum (atomic number 57) to lutetium (71). Together these closely related elements, with their compounds, form a hitherto little known but potentially valuable range of materials.

For some years active research on the rare earths has been carried out by Johnson Matthey, and supplies of the rare earths in their normal form as oxides have been available in several grades of purity. Improved techniques for the production of the metallic elements have now been brought to fruition, and all of the 14 naturally occurring elements, together with the closely related elements scandium and yttrium, are now available in a variety of forms.

The metals are reduced from their fluorides with lithium, calcium or lanthanum in tantalum crucibles in an atmosphere of argon, and are then remelted in vacuum. Impurities are held at a very low level and in some cases the purity is higher than has hitherto been achieved.

Lanthanum, cerium, praseodymium and neodymium oxidise readily at room temperature and must be preserved in airtight containers, but all the other metals, except europium, acquire no more than a superficial tarnish on prolonged exposure to the air at room temperature. Europium is highly reactive and therefore difficult to preserve and handle as metal.

All of the 16 metals have been remelted into ingots or rods. Lanthanum, cerium, neodymium, praseodymium, yttrium and gadolinium have been successfully extruded, and subsequently drawn to fine wire.

STRONG STAINLESS STEEL

Two new 60 ton tensile stainless steels especially suitable for turbine blading are now being produced by Firth-Vickers Stainless Steels Limited of Sheffield. They are martensitic and have been called FV566 and FV520. With chromium contents in the range 11 to 16 per cent, they are distinguished from the older martensitic stainless steels by lower carbon (0·03 to 0·12 per cent) and higher nickel contents (2 to 6 per cent). They carry, in addition, 1·5 per cent molybdenum together with vanadium or copper, and niobium.

Strength for strength, these alloys offer better corrosion resistance than their predecessors. FV520 is the most highly alloyed of the two, but has corrosion resistance equivalent to that of the austenitic 18-8. It is weldable and its impact strength is retained down to − 80° C.

After what is described as "exhaustive testing" of full scale blades, English Electric Company of Rugby have chosen these new alloys for use as 36 in long forged low pressure turbine blades in their 275 MW steam turbine generating set. The blade tip diameter of the complete rotor is over 11 ft and this runs at 3,000 r.p.m. in wet steam.

Centrax Limited of Newton Abbot are machining gas turbine compressor blading from FV520 for their 430 h.p. CT7 unit, and the same alloy has been incorporated in blading for the Bristol Proteus engine.

STANDARD FOR BOURDONS

Did you know that a Bourdon tube could be oval? Not only is this so, but such tubes are now defined by a series of standard sections, all of which are laid down in a new British Standard, number 3127 : 1959, "Ferrous and Non-Ferrous Bourdon Tubing." From the title it is seen that the emphasis lies on the materials from which the pressure sensitive tubes are made. They include beryllium, copper and brass, two other non-ferrous alloys, and four steels.

There are three appendices—the last on "Guidance on Microstructure"—from which one learns that the "grain size should be reasonably uniform, avoiding excessively large or small grains"; such adjectives are rather woolly, but are luckily backed up by figures—there should be, for instance, a minimum of 30 grains across a wall of 0·025 to 0·050 in thickness, if made of phosphor bronze.

Obtainable from British Standards Institution, 2 Park Street, London. W1. (6*s*.)

Blade-Type Blower Works on New Principle

This blade-type blower, an entirely new departure, results from a study of compression processes and the need to improve on the Roots-type.

A blade-type blower working on an entirely new principle has been developed by the British Internal Combustion Engine Research Association, Slough, Bucks. The machine is the result of a study of compression processes and the need for a better (but no more expensive) machine than the Roots-type blower.

This new and attractive compression cycle was developed in its most elementary form so that, in addition to being a prototype test machine, it could bear a close resemblance to future commercial machines. There is a wide range of design variables and the machine described here is not the only form in which the principle can be applied.

The object of the design was to obtain continuous inlet and delivery processes at constant velocity and an efficient compression process. In the interests of low cost and reliability it was thought necessary to break away from the normal two-rotor type of machine which requires accurate phasing and also an expensive gear train.

In this machine the intake, compression and delivery processes take place in an annular channel formed in a rotor. At all times this channel is divided at two points (X) and (Y), as shown in Fig. 1. Division X is a local constriction of the channel and Y a thin blade which can turn on its own stationary axis. When positioned across the channel, this blade forms a blockage so that the revolving of the constriction acts like a piston, causing an increase in channel volume on one side and a decrease on the other. This gives intake and delivery through ports in the walls of the channel. Before the revolving piston reaches (Y), the blade is turned through 90° so that it can pass through a narrow slot in the piston as it passes over the blade. A sequence of blades gives continuous seals both in the piston and as partitions dividing the channel (Fig. 2).

During rotation of one blade relative to the next, the space between them varies, and this feature may be used to obtain internal compression (also shown in Fig. 2). A fresh charge taken in at (*a*) is trapped as volume (*b*). By keeping this space sealed by making the channel converge, the air can be compressed to volume (*c*) before this becomes part of the delivery space (*d*).

The design was, however, modified to the form of Fig. 3, to reduce production costs. Here alternate blades have been replaced by stationary spacing pieces (*f*) which maintain the seal in slot (*e*). Space (*b*) is now so large (and so shaped) that its volume does not change rapidly with blade tilt and so compression takes place by back flow. This is no great loss for low-pressure machines, for the back-flow compression takes place in the stationary enclosed space (*b*) and imposes no torque load on the working mechanism. The process is therefore more efficient than the back-flow compression that occurs in Roots-type blowers, which heavily loads the approaching lobe.

It is a fortunate property of the geometrical arrangement that, with the blades turning in the same direction as the rotor and at half its speed, they always point to the centre of the slot (*e*). In this way they feed themselves through the narrowest possible slot. The minimum width of slot is determined, not by the geometry of the process, but by the thickness of the blades at the hub. These have to be strong enough to take the air loading over the full area of the blade without causing a deflection at the tip greater than the clearance permissible when the blade passes through the slot. On small machines the blades are over-hung from their supporting shafts. On larger machines it would be possible to insert bearings at the remote ends of the blades, so that a greater blade length to diameter ratio could be used.

The blades are mounted on shafts that rotate in a back plate which also supports the blade spacing pieces (Fig. 4). A gear train giving a 2 : 1 reduction in speed (Fig. 5) drives the blades and keeps them in phase with the rotor which is driven directly by the main shaft. This shaft transmits all the power required for the compression process, leaving the blades free to rotate without doing work on the air. Fig. 6 shows the complete machine.

DESIGN CONSIDERATIONS

(i) Air leakage is one of the three most important sources of efficiency loss in rotary machines, and machining to fine clearances one of the greatest reasons for high cost. The aim has been to reduce fine clearance surfaces to the simplest possible shapes and to make the clearances (as far as possible) independent of the accuracy of the phasing of the blades. The sealing faces between the rotor and casing require only simple turning, as do the faces of slot (*e*) and of the spacers (*f*) in Fig. 3. The length of slot (*e*) is such that it spans the gaps between the spacers and the hubs of the blades. Since these hubs have a diameter equal to the width of the slot in the rotor, the blades have a degree of freedom to rock on their own axes as the slot passes over them, without the seal being broken or the tips fouling.

The seal made by the blades on the opposite side of the channel (that is, where it is at its widest) is also made between arcs of circles. The tips of the blades are radiused so that again the blade has a certain degree of freedom to rock on its own axis without altering the tip clearance. The only surfaces of the channel that need accurate machining are the slot (*e*) and the walls enclosing the space (*b*). The remainder of the channel is best designed to leave an adequate air space around the blades. In practice, the shape is usually settled by the dictates of sim-

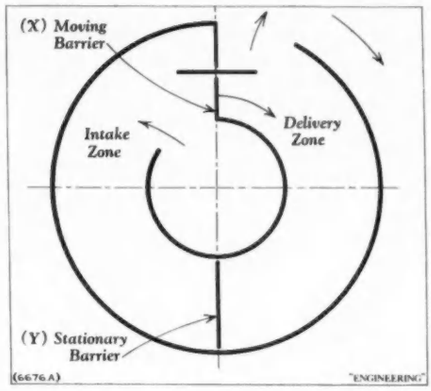


Fig. 1 Descriptive diagram of mode of operation.

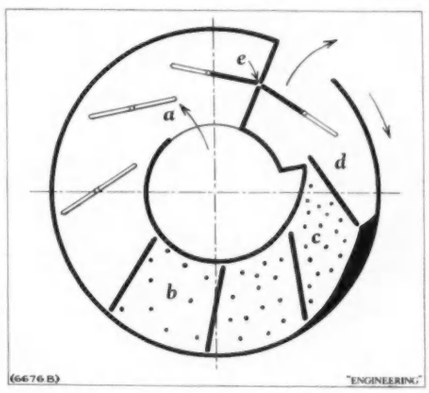


Fig. 2 Modified form giving internal compression.

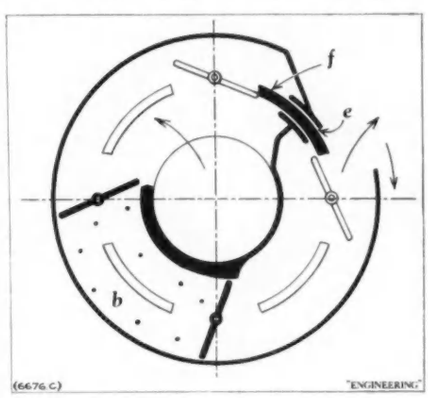


Fig. 3 (above) Shows stationary spacing pieces.

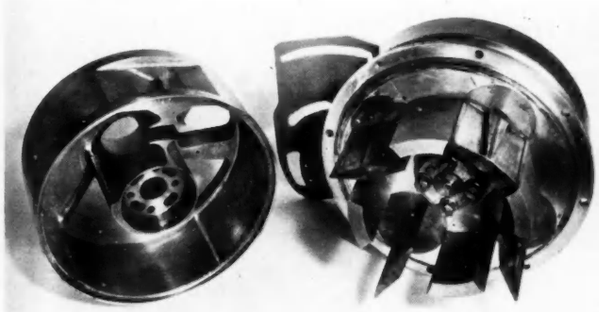


Fig. 4 (left) Details of blades and back plate.

Fig. 5 (right) Gear train with a 2 : 1 reduction.

plicity of machining and the requirements of balancing.

(ii) The second important source of loss in air compressing machines is due to air flow throttling losses. To a large extent, these determine the operating speed, which in turn not only determines the size of machine required for a given purpose, but also has a direct influence on its efficiency. Raising the speed increases the throughput without increasing the leakage.

It has been found possible with this type of blower to have ports approximately equal in area to the cross-section of the channel at (*b*), so that the air speeds are comparable with the rotor velocity at the mean channel diameter. With the air passing through constant areas of port and channel, there is little throttling loss. In fact this process is similar to that in a normal piston compressor with both the inlet and delivery ports equal in area to the whole of the cylinder head. In addition, the flow is assisted by taking the air into the centre of the rotor and passing it radially outward, as the natural centrifugal effect of the spinning rotor tends to pass through the air in this direction.

(iii) The third important loss is the friction of the mechanism. The parts carrying out the compression process do not need lubrication, so the only friction losses are those of the bearings and gears. The single rotor runs on two ball bearings and its shaft transmits all the compression power. The four blades also run on ball bearings and since they run at only half rotor speed, the frictional losses are low. The gear-train loading comprises only these bearing friction losses and so gives a very small power loss. The light loading (and the fact that phasing accuracy does not have to be of the first order) means that a light and relatively cheap gear train can be used.

The approximate swept volume of this type of machine is given by the flat surface area of the blade minus its thickness area times the blade pitch circle circumference. For an accurate figure, a small allowance has to be made for the tilt of the blades on either side of the trapped volume.

The specification of the prototype test machine is:—

Swept volume	0·0555 cu. ft per rev
Max. operating speed	4,500 r.p.m.
Max. delivery pressure	5 lb per sq. in gauge
Blade size	3 in × 2·5 in dia. × 0·45 in
Pitch circle diameter	5·2575 in
Casing overall size	9·25 in dia × 8·65 in
Weight of test machine	About 40 lb

Fig. 7 shows the set of machined parts before the assembly of the first machine and the gear cover, back-plate, rotor and delivery air casing. The rotor was cast aluminium alloy and designed to be in dynamic balance. Originally this was overhung from the main shaft, but a better performance was obtained by supporting it at its outer end in a large diameter ball race, mounted in the delivery air casing. At the same time the blade design was also modified.

The blades (integral with their shafts) are machined from steel strip. The gear train consists of a steel pinion, bronze idlers and cast-iron blade gears. The steel pinion should be (but was not) hardened, for in this case it was desired to accelerate gear wear to show that backlash of $\pm$ 1° on the main shaft could be accepted by the mechanism. The large gears dip in an oil bath for lubrication. The bearings closest to the air space are of the grease-packed, neoprene-sealed type to act as a barrier between the oil in the gear case and the air.

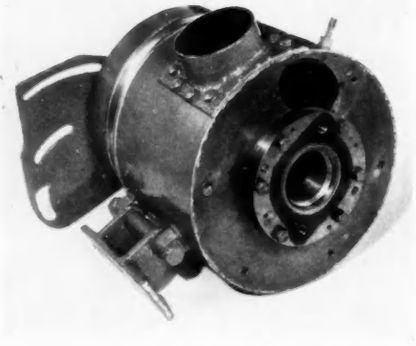


Fig. 6 Complete machine, showing brackets for mounting and the blanked-off alternative port.

OPERATING SPEED AND PRESSURE

The experimental blade-type blower was designed as an engine pressure charger for relatively low pressures, the first target being 5 lb per sq. in gauge at 4,500 r.p.m. This gave a rotor having a rim velocity of 160 ft per sec and a mid-channel velocity of about 100 ft per sec. So the air velocities in the ports were of the order of 100 ft per sec, which is lower than that commonly used in engine manifolds. For tests, the blower was mounted on a swinging bed dynamometer for power input measurement and was coupled to a large meter of the air-box type for air flow measurement.

Performance tests were carried out up to the design condition of 5 lb per sq. in gauge at 4,500 r.p.m., but the results are not shown here.

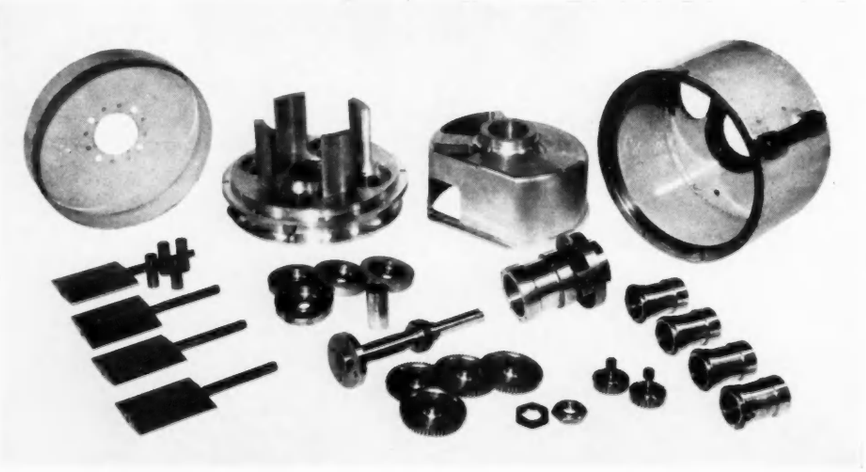


Fig. 7 Machined parts before assembly. Back row (left to right) shows the gear cover, back plate, rotor and delivery and casing. At left front are the four blades and at right front their bearing mounts, while in the centre is the main shaft and its bearing mount with the gears in the foreground.

The useful range of running conditions at 55 to 60 per cent efficiency compares favourably with that of any other type of machine of comparable throughput, whether blower or compressor. The efficiencies based on air temperatures were higher than the overall figures, since they profited by the heat losses during compression and delivery. The heat losses are large and the temperature differences very small at low speeds and delivery pressures, and the figures have little significance under these conditions. However, at the higher outputs the figures are of value and at 3 lb per sq. in gauge or more the temperature efficiency figures average seven units higher than the overall values.

After testing this machine on an engine, it was found desirable to extend the working range to 5,000 r.p.m. and 6 lb per sq. in gauge delivery pressure, to match an engine speed range of 3 : 1. To achieve this the rotor rim clearances were increased, and this reduced the efficiencies by about three units.

In this latter form the blower was used for 65 hours of engine testing. Its use resulted in a 20 per cent increase in engine torque, with very little increase in the specific fuel consumption.

The blower is not particularly noisy; at low speeds and pressures it is, in fact, very quiet. Only when engine speeds were above that which gave 4,150 r.p.m. at the blower and 4·5 lb per sq. in gauge pressure, did the blower noise noticeably exceed the engine noise. A simple inlet silencer reduced the noise below engine level up to the maximum speed of 2,200 engine r.p.m. The principal source of noise is the expansion of the small pockets of air on either side of the blade tips, which are carried through the slot in the rotor from the delivery to the inlet space. The small pockets of air expand rapidly in the inlet space, creating noise and tending to excite the natural frequency of the inlet duct.

APPLICATIONS

While the experimental blower was made specifically for low pressure charging of a 4-stroke-cycle engine, it is most suitable for supplying the scavenge air for 2-stroke-cycle engines. The outer casing is, in effect, a built-in delivery capacity chamber which gives the advantages of damping out pressure fluctuations and permitting a wide choice of delivery duct positions. So, although this blower is fatter than the bare Roots-type machine, in most cases the latter has to be fitted with inlet and delivery ducts which destroy its slim lines and make the sizes and shapes more alike.

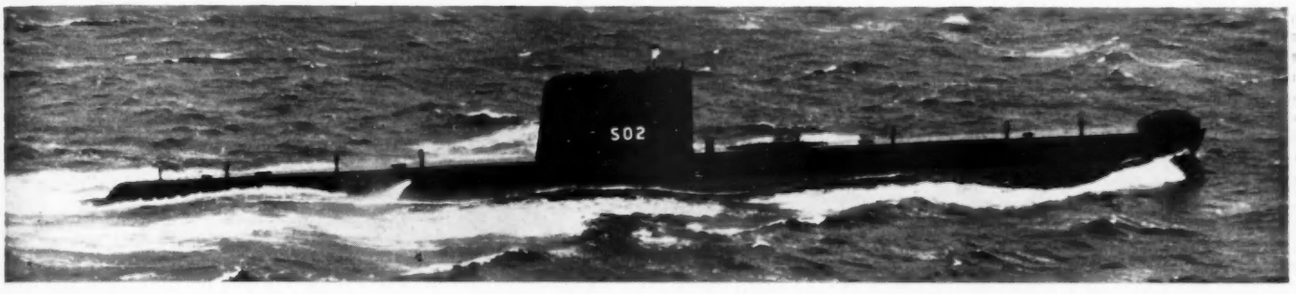
The basic principle of this compresion cycle can be used for any size of machine. However, as with all rotary blowers having clearances around the working parts, the efficiency would fall rapidly for sizes under 50 cu. ft per min. Very small units could be made for pumping liquids, and this principle could be used for a very efficient oil or fuel pump. The cycle gives steady flow free from fluid trapping, and the flow is assisted by a small centrifugal head.

For larger sizes of machine (over 500 cu. ft per min) it may well prove economical to use a more complicated mechanism, to reduce the overall bulk per unit of swept volume and to assist fabricated construction methods. The machine would then be simpler to produce in small numbers than the Roots-type or others that require complicated rotor and casing castings.

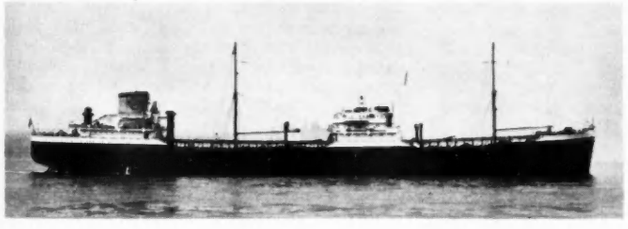
This design would have a rotor giving two air cycles per revolution, and this leads to a rotor which is in natural dynamic and pressure balance. A greater number of blades would be necessary and these would be thicker in relation to their diameter. This facilitates the fitting of bearings at the outer ends of the blades, a ring supported by the spacing pieces being used to mount these bearings. By the use of this extra support, a greater blade length-to-diameter ratio could be used. In this design the blades would turn at the same speed as the rotor.

From the shipyard of Blohm and Voss AG comes this German navy training ship. A three-masted barque of welded construction, it carries 220 cadets. Sea trials will make certain that the boat is safe.

The Eriksberg M/T Bogota, of 19,600 tons, ordered by the Texas Co. (Norway), has 30 tanks.



HM submarine Rorqual (the second of the Porpoise class) is capable of high underwater speed and continuous submerged patrol in any part of the world. She is soon to be commissioned at the Barrow-in-Furness yard of Vickers-Armstrong Limited. The submarine has a cinema projector and a tape recorder.



The Shell tanker Auris (originally a motor ship) now has a 5,500 b.h.p. open cycle gas-turbine. Power is transmitted by double-reduction gearing.

One of the designers, Ian Proctor (the other is S. S. Wilson) with the 12 ft dinghy made by Bristol Aircraft Limited and claimed to be unsinkable.

Britain's most up-to-date aircraft carrier, HMS Victorious, is fitted with advanced radar equipment that gives precise information on aircraft targets.

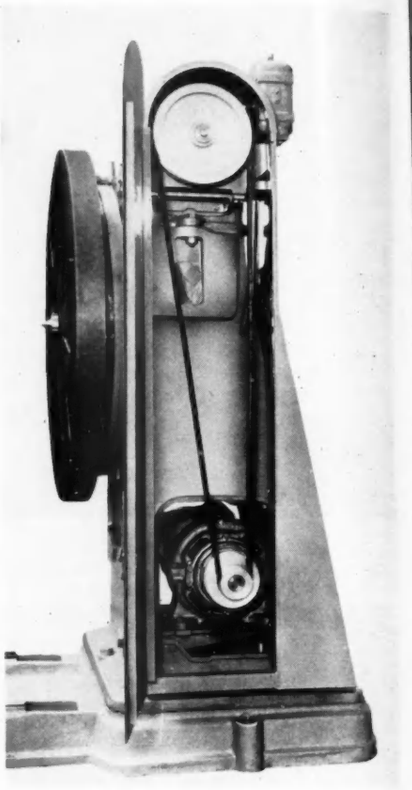
REGULATOR USES EDDY CURRENTS

A speed regulator (see right), that uses eddy-currents to transmit a specific torque, has been introduced by Westool Limited, St. Helen's Auckland, Co. Durham. The design is such that it can be used for a variety of applications. It can be vertically or horizontally mounted, it has a very rapid response (to meet the needs of fully automatic systems) and it functions effectively with only light power control gear.

The regulator, which is intended for use as a coupling, a clutch and a torque limiter and controller, can be remotely or directly controlled. The unit has already been successfully used on coil-winding machines, printing machines, winches and mine cages. Other applications are being studied and tests carried out at the Westool factory and in works all over the country.

It has a stator with a stationary field coil, in which rotates an annular rotor (attached to the driven load) and a central rotor (driven by a prime mover). When there is no current flowing in the field winding, the input shaft and rotor run idle, while the annular rotor (coupled to the output shaft) remains stationary. When direct current is fed into the field winding, a magnetic field is created which causes the annular rotor and the output shaft to rotate. The speed of the output shaft depends on the exciting current in the winding and on the torque to be supplied.

The Elcotron is ideally suited for remote control applications, for the wattage controlling the excitation of the regulator is only a fraction of the h.p. that can be transmitted. For example, 1 kW can handle a transmitted power of 200 h.p. Its speed can be manually or automatically controlled and infinite variability (from zero to just below the speed of the driving motor) is possible with an induction motor.



TUGBOAT TOWING WINCH

When a vessel is towing a cargo boat in heavy water there is difficulty in keeping a constant distance between tug and tow (that is, a uniform length of stretched line). As the tow is drawn nearer to the tug, the line slackens and may foul the propeller, while if the two vessels move further apart, there is a sudden pull on the tug.

The tow line is normally fastened to the tug by the braked drum of the winch and this enables the tow to be set at a convenient initial distance from the tug by hand or power drive of the winch.

Automatic control has, however, become essential for successful towage in stormy seas. It is carried out by an automatic towing winch, in such a way that the tow-line is automatically unwound if the rope tension exceeds the permissible limit (or wound up if it is reduced) without the tug having to change its speed. Automatic towing winches of various designs have been constructed and successfully tested, according to an article in Czechoslovak Heavy Industry, No. 10, 1959.

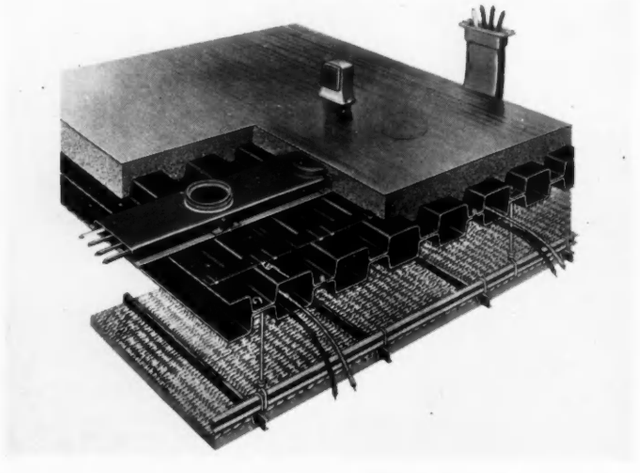
CELLULAR STEEL FLOOR CONSTRUCTION MOST EFFECTIVE

A sheet-steel floor construction known as Q-Floor (Robertson Thain Limited, Ellesmere Port, Wirral, Cheshire) is proving popular. It consists of hollow cellular steel units laid on (and fastened to) the structural framework of the building. These units themselves can stand quite a high superimposed load and so serve as a secure working platform just as soon as they have been laid. The full structural characteristics of the floor are not assumed, however, until the concrete has been laid on top of the steel. It is bonded to the cellular units by straps to give a composite floor, with the concrete acting in compression and the steel in tension. The cells of the steel units form a series of electrical ducts at 8 in centres.

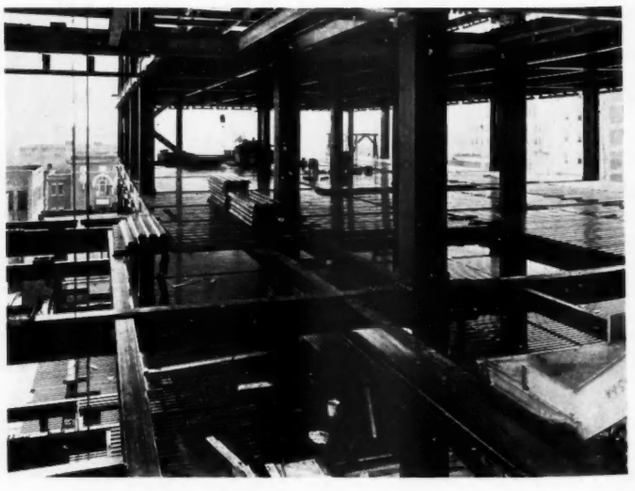
The cellular sheet steel floor units are available in four sizes: 1½, 3, 4½ and 6 in deep, and so it is possible to cater for a wide range of load-span conditions. On the basis of a deflection not greater than 1/325 of the span, the smallest units (after the placing of 1¾ in structural concrete ¾ in screed) can carry a superimposed load of 346 lb per sq. ft at 6 ft centres. The largest unit (under the same conditions) carries a superimposed load of 81 lb per sq. ft on a 24 ft span.

When full electrical availability is not required, the smaller cellular units (1½ in and 3 in deep) can be interspersed with single-skin units, so that the under-floor ducting is only used where necessary. These single-skin units (and the upper sections of the cellular units) are made of 16 gauge zinc-coated steel. The lower sections of the cellular units are of lighter gauge.

The system is light. The steel units weigh between 5½ and 7½ lb per sq. ft and the completely concreted floor only about 40 lb per sq. ft. A small total dead load like this saves in the weight of structural members and foundations.



Cut-away section of cellular sheet steel floor, showing its construction.



Typical installation of cellular steel floor, showing its use as a working platform.

Precision Production in a Laboratory

Instruments for inertial navigation present as many problems in their manufacture as they do in their design. The production area must be dust free, and the humidity and temperature have to be closely controlled.

An extension to an existing laboratory at Crew Toll, Edinburgh, is to be used by Ferranti Limited for producing a new series of high-precision gyroscopes and accelerometers for aircraft, missiles, submarines and other vehicles. Production of these instruments has been going on for the last 18 months, but the new extension provides a completely integrated development and manufacturing establishment.

Entirely functional in appearance, the extension provides an additional floor area of about 17,400 sq. ft. It comprises machine and process shops, assembly and test areas, stores, laboratories and offices.

The manufactured instruments are components of inertial navigation systems, which are used to "fix" a vehicle in three dimensions with respect to its starting position. By assuming the present position of the vehicle and its target, and with an accurate knowledge of the value of g, a measure of the acceleration form the point of take-off in three mutually perpendicular directions, integrated twice to give the distance travelled, leads to this "fix."

The manufacture of instruments for inertial navigation presents just as many problems as their basic design, and indeed, in much of the work, the two problems are inseparable. It is imperative that no dust particles greater than about 0·5 micron in size or excess moisture are present in the area where assembly of these instruments takes place. For this reason, the assembly and inspection areas and the store room for finished parts are temperature, humidity and dust controlled. Special precautions have to be taken to ensure that machined components do not carry any particles of dust from the machine shop into the clean areas. This is achieved by a system of double air locks between the machine shops and a special cleaning room which is equipped with ultrasonic cleaners. A second double air lock between the clean room and the air conditioned store room ensures the minimum transfer of air, and hence dust, between the conditioned and non-conditioned areas. Strict precautions are also taken to ensure that dust particles, pieces of hair and other foreign matter are not carried into the clean areas by the operatives.

On entering the extension, they cross a long mat to remove any mud from their shoes. After leaving their outdoor clothing in the cloak room, they enter a shoe changing room which is divided by a low bench on which they sit to remove their shoes and socks. After they have done this they swing their feet over the seat and put on special socks and leather shoes similar to carpet slippers, but which are lint-free. The operatives are then required to go through the two stages of undressing and dressing with special clothing, during which time at intermediate stages they are subjected to blasts of high-velocity filtered air to remove loose particles. When the final garments have been put on, the only exposed parts of the body are the hands and face. The clothing is specially designed for the work and consists of a nylon hat, nylon overalls and nylon boots which fit over the leather shoes. Care has been taken to avoid dust traps in the design of the clothing.

The air conditioning of such a plant presents a number of problems. As compressors would cause undesirable vibrations, the main plant employs an absorbtion cooling machine. It is of sufficient capacity to provide cooling water for both the main plant and for a plant situated in the changing rooms. The air is controlled at a dry bulb temperature of 72° F, plus or minus 1° F, at eight points of control within the air conditioned areas. Good draught-free diffusion of air is obtained by means of perforated dome-type secondary air diffusers on the ceiling. This secondary diffusion, in spite of 16 air changes per hour, moves the air gently and imperceptibly downwards to be extracted through grills at floor level. Because excessive humidity would be harmful to the manufacturing process, the air conditioning plant automatically controls it to a maximum of 45 per cent relative.

The air is filtered by passing it initially through glass-fibre primary filters, and then through two large banks of high efficiency filters, the last bank being installed to provide an effective barrier between the clean and dirty side when the first bank of high efficiency filters is being changed. It is claimed that these filters have an efficiency of 99·98 per cent. Using the methylene blue British Standard tests, it was shown that only 0·2 per cent of the methylene blue cloud, having particle diameters of between 0·1 and 0·5 micron, passed through the filters.

Fluorescent lighting for the air conditioned areas is installed in an attic space above false ceilings, the light being diffused through dust-tight panels. The level of illumination is high —of the order of 80 ft candles at bench level. Telephones in the extension are connected with jack leads so that they can be removed when necessary for repair, and a two-way intercommunications system in each interview room allows personnel inside and outside the clean area to converse.

Considerable precautions have been taken to isolate ground-transmitted vibrations from the test area. Special mountings have been installed to carry test equipment for the instruments. Conditions for one instrument in the extension required that the mounting carrying the test gear would not be subjected to rotations greater than one second of arc or translations with acceleration greater than 0·0001 g. In a pit underneath the main floor of the test area, there are three large reinforced-concrete blocks. The first of these weighs approximately 60 tons, and the other two about 40 tons each. The large block, and one of the small blocks, are each mounted on four rubber pads, with rubber side buffers to reduce vibration in the vertical and horizontal planes. These two blocks, the tops of which come to within about 12 in of the underside of the suspended flooring over the pit area, carry a number of aluminium-alloy pillars filled with concrete, each weighing approximately one ton. These pillars pass through the flooring. A flexible dust seal is fitted between each pillar and the floor, so that vibration is not transmitted from the floor. The third concrete block carries one test pillar only and is suspended on 16 helical coil springs, thus gaining better isolation from disturbance than the other two. Damping is achieved by dashpots filled with silicone oil.

The need for extreme accuracy in inertial navigation systems is the justification for all these precautions. The work in the laboratory will be concentrated on the development and manufacture of the components only, but the scope of its work is later expected to include the development and building of inertial navigational systems. Much of the present work is concerned with the manufacture and further development of a single-axis floated rate-integrating gyro, manufactured under licence from the United States, and a pendulous integrating gyro accelerometer, the development of which has been undertaken completely at Edinburgh. It is also expected that future development work will cover smaller gyros of roughly equivalent performance to the present design.

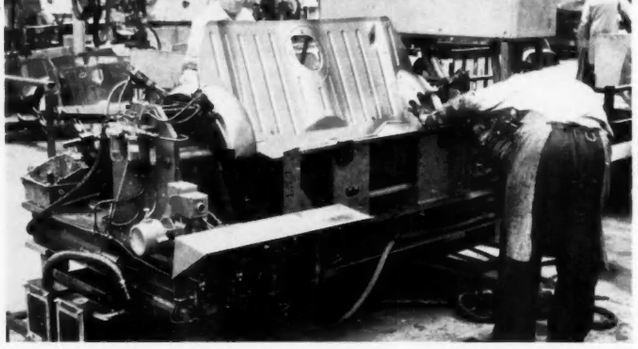
(*Above*) *The testing section of the new Ferranti production laboratory.*

(*Right*) *Assembly of a component for an inertial navigation system.*

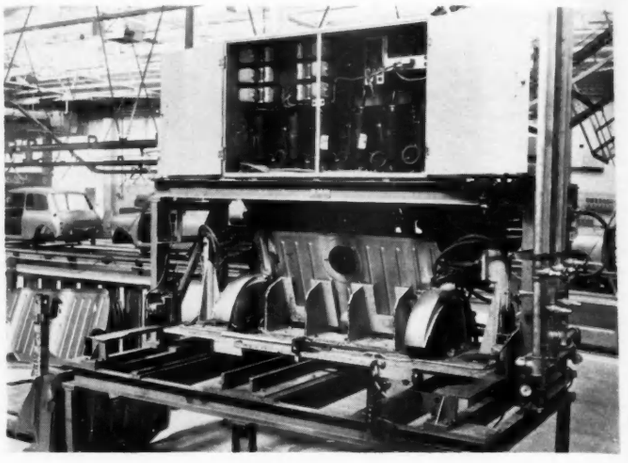
SPOT WELDING THE NEW AUSTIN BABY CAR

The design of the new Austin 7, which was announced on 25 August, incorporates many novel features in its production as well as in its design. Production of this car is expected to reach a peak of over 3,000 per week.

The design of the engine mountings and chassis frame, coupled with the need for minimum body weight with maximum strength, led to the specification of a body of all steel welded construction, with the chassis forming an integral part of the body. The chassis consists of two sub-frames, one in the front and one in the rear. This type of construction led to a call for the simultaneous welding of a large number of high quality spot welds. This requirement has been filled by six purpose-built spot welding machines designed and manufactured by Messrs. Electro Mechan-Heat Limited, Kingston on Thames. Their multi-spot welders incorporate locating and jigging fixtures and air operated ejection mechanisms to ensure a high degree of accuracy and dispatch.



(*Right*) *Rear wheel arches and seat base of the Austin 7 being spot welded.*



(*Left*) *Assembly of the seat panel and rear floor of the Austin 7.*

The first of these machines attaches the rear seat panel to the rear wheel arches by means of eight spot welds on each side. In this machine, four 75 kVA packaged transformers are connected across the three phase power supply with an electronic control unit firing the first two transformers together and the others one at a time. A five stage weld timer (a modified version of the company's three stage timer) provides sequencing switching of the three ignition contractor units mounted inside the control box, to give three weld sequences, a forge time cycle and an interlock stage. The components to be welded are pneumatically clamped in position on a hand operating trolley. The trolley, on being pushed forward to the welding position is pneumatically locked and the welding cycle is automatically initiated.

A second machine attaches the rear floor panel to the rear wheel arch and seat panel assembly by means of another eight welds on each side. A pneumatically operated table, built into the machine, provides an easy working surface for loading and also acts as an automatic ejector on completion of the welding operation. The control unit is the same as the one mentioned in conjunction with the first machine.

A multi-spot welder equipped with the two 75 kVA packaged transformers tack welds four seat hinge brackets and two boxing plate angles to the U-section front seat cross member. In this machine the manually operated table is indexed through six welding positions, the positions being selected pneumatically. Particularly interesting, are the hinged lower electrode blocks which flap into place inside the ends of the floor cross member for attachment of the two boxing plates. Each of these electrode blocks is cut away to allow two welding guns to descend vertically and make two series welds. Two more guns close in from either side to make series welds in the sides of the cross member, the welding current being carried across the U section on the electrode block. Direct welding is used in the fixing of the seat hinge brackets. The timing unit comprises three standard two-stage timers, two of which control the weld and forge times, while the third acts as a built-in spare.

The floor pan of the car body is attached to the front seat cross member and heel board member by means of 82 welds from a large multi-spot welder incorporating a pneumatically operated table. Two welding trolleys, one on each side, are automatically indexed to the welding position, using air motors attached to the trolleys. The drive comes from sprockets on the drive shafts of the motors, which engage with lengths of chain fitted between the trolley tracks to provide a rack and pinion movement. The pneumatics of the circuit are so arranged that only one trolley will operate at once. When the trolley reaches the welding position, the 82 welding guns descend simultaneously. There is a specially designed timing unit, which selects in turn from three bands of six 75 kVA transformers and one of three transformers—through a four sequence contractor arrangement. The control unit ensures that no more than two transformers are fired at any one time.

Another large spot-welder with a welding trolley similar to that of the previous machine is used for welding the heel board and seat cross member to the floor pan in the curve of the transmission tunnel. Again in this machine, an air motor is used to index the trolley forward through six welding positions, the positions being selected by an electropneumatic circuit. The welding guns are crossed to enable groups of four spot welds to be made in pairs inside the small radius curve of the tunnel: they are also slightly offset so as to bring the spots exactly in line with the stiffeners.

A multi-spot welder with a hand-operated table welds the four sections of the radiator surround after positioning them. The assembly is indexed through four welding stations during the course of the operation.

All these machines have been designed so that, by means of sequence welding, a maximum of 1,000 A is drawn from the 400 V mains. Weld spots of 2 in pitch are achieved by using Savair-type tandem air cylinders, which, with a 90 lb per sq. in air line, produce electrode tip pressure of 400 lb per sq. in.

ONE FACTORY REPLACES THREE

A new factory, opened on 18 September, marked the beginning of a new era in the life of J. H. Carruthers and Company Limited of Glasgow. Until the opening, the famous crane and pump manufacturers had been working in shops and offices which were inconveniently scattered. The company were suffering from overcrowding in the factories, lack of space for expansion and the high costs of transporting materials and components between the original three factories. A set-up which had been adequate during the Second World War and before was seen to be unsatisfactory if the firm were to continue expanding at the same rate as they have been since the end of the war.

Originally the company had three factories, at Polmadie, Lambhill, and Parkhead. The Polmadie works housed the pump division, and a machine shop common to both the crane and pump divisions. At the other two sites the company's cranes were manufactured. The new site brings all these operations under one roof, the production areas for the two main divisions running parallel to one another separated by stores and offices.

The factory covers an area of 74,500 sq. ft. Its bays are portal framed structures designed to carry 25 ton overhead cranes of 70 ft span. The building has been designed to comply with the latest legislation for thermal insulation.

A generous allowance has been made for natural lighting by means of roof and side wall windows. This, combined with the light colour scheme of the factory, produces a high level of natural illumination. Artificial lighting is provided by mercury vapour fittings which give an illumination of 17 ft candles at working level.

The factory and offices are heated from three electrode hot-water boilers producing 7,400,000 Btu per hour. The system is fully automatic and operates on an off-peak tariff.

A liquid oxygen plant has been installed. Together with a bulk propane supply, it ensures that gas is always available in the fabrication shop. It also eliminates completely the handling of cylinders inside and outside the shop.

Operation and Maintenance

A NEW LANGUAGE FOR COMPUTERS

To simplify further the instruction, or programming, of electronic computers for commercial work such as payroll, inventory and production planning, IBM United Kingdom Limited, 101 Wigmore Street, London, W1, have developed a new language.

Such simplification has long been achieved by IBM in the scientific field with "Fortran" (formula translation), where the precision of the traditional mathematical terms lent itself to adaptation for the purpose.

The development of a similar computer language for commercial use was handicapped by the lack of a standard business terminology. IBM research first concentrated on an analysis of a large number of commercial problems already being processed by electronic computers. As a result of this analysis they were able to construct a language in which these problems could be stated in terms of fifteen basic computer functions (arithmetic, logical decision making, editing and other data handling operations).

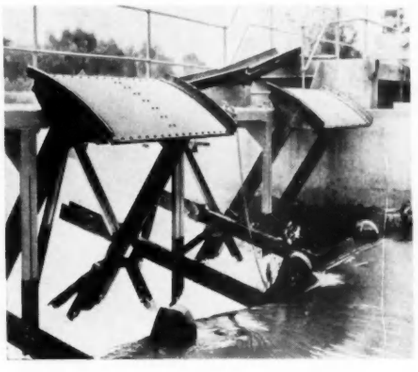
This language, called "commercial translator," consists of normal English words which will be converted inside the computer into detailed machine instructions. It can be used with the larger existing IBM computers, and will be compatible with future IBM computers.

Commercial Translator is so like normal English that a person completely unfamiliar with computer programming can be trained to use it in a matter of days, merely by learning a few rules of vocabulary, sentence formation, use of suffixes and punctuation. A typical statement in this new language to describe the procedure for re-ordering when stocks are low might run as follows: "If stock level is less than 1,000 or reserve level is zero then set order amount equal to 5,000 minus stock level; move order record to order file; go to next item."

The great reduction in the length of programmes will mean enormous economies in programming and debugging time, and will make it possible to programme the production of special reports in a fraction of the time formerly necessary.

LIGHT ALLOYS IN SERVICE

Just over eight years ago 31 light alloy sluice gates were installed on four Thames weirs. The gates, which were fabricated from "Birmabright" standard extruded sections and have skin plates and rivets of the same material, made by Birmabright Limited, Woodgate Works, Birmingham 32, are only half the weight of similar gates made of steel, and are counterbalanced for easy hand operation. They have recently been examined by representatives of the makers, who reported that they show no deterioration whatever.



After eight years of service at Thames weirs, Birmabright light alloy sluice gates are still in perfect condition.

FINDING FLAWS IN AIRCRAFT

A commercial aircraft only earns money while it is flying. Overhauls are essential, but they keep the aircraft on the ground. To stretch the life between overhauls, therefore, is to increase the aircraft's capacity to make a profit. Bristol Aircraft Limited, Filton House, Bristol, have speeded up maintenance with their new eddy current flaw detector. It simplifies some types of major inspection, and reduces time and labour costs greatly, because, in most cases, examination can be carried out without major dismantling.

In searching for fatigue cracks, which may develop during the service life of an aircraft, traditional methods of inspection either do not work at all, or they are not infallible. In addition, they take up a lot of time. Conventional inspection of a main spar boom, for example, could, on a large aircraft, take hundreds of man-hours. With the eddy current flaw detector the job can be done, and done more effectively, in as little as four man-hours. Because the traditional method can only be used at the time of a major overhaul, the overhaul life has to be very conservatively estimated. With the flaw detector, on the other hand, a regular check can be made, and overhaul can be postponed until it is shown to be necessary. It is estimated that the overhaul life of a spar boom can thus be trebled.

There is, of course, nothing new in eddy current crack detection; an alternating current is passed through the metal under examination, and a crack in the metal causes a change in the current flow, which is indicated on a meter. Bristol's achievement has been to embody the principle, for the first time, in a small and handy instrument which, energised by a battery, is fully portable and can be used in the field. It weighs only 8½ lb.

A standard test block, made of light alloy, and having "good" and "bad" holes in it, is included in the detector kit. The meter can thus be calibrated immediately before an inspection, which is one of the advantages of this procedure.

Marketing

Macey's and All That

The second party of young executives from British consumer goods industries left on 13 September to work in North American stores. The 24 members of the party, including two women, will fan out to department stores in cities throughout the US and Canada. For more than a month they will serve across the counter and work behind the scenes in the stores observing ways in which Britain can increase her exports of consumer goods. The members of the second party have spent a fortnight working in Harrods and Selfridges to gain experience of selling, as did the first group.

The visits, which were first suggested at the Dollar Exports Council Conference at Eastbourne last December by Mr. Joseph P. Kasper, president of Associated Merchandising Corporation of New York, have been sponsored jointly by the Corporation and the Council.

Holiday Month in Trade

Exports and imports were lower in August than in July, but this does not suggest that the increase which has been taking place in world trade has come to an end; some fall was to be expected as a normal seasonal movement. The visible trade deficit was smaller, although the provisional figures published by the Board of Trade show that little change has in fact taken place in the balance of British trade over the past five months. The excess of imports c.i.f. over exports and re-exports f.o.b. in August was £40·5 million compared with £55·8 million in July. The monthly average for the five months April-August was almost the same as the average for January-March although the average for the eight months January-August was some £9 million higher than during the same period of last year.

The fact that there has been no appreciable change in the balance of trade over the past eight months suggests that the steady deterioration in the general position which took place last year has been checked. On the other hand the running down of stocks may have played a part, in which case imports could be expected to rise sharply over the next few months. In January-August they were 5 per cent greater than in the same period of 1958: the corresponding figure for exports was 3 per cent. The improvement in the position took place in the 5 months April-August when the monthly rate of exports rose by 5½ per cent and that of imports by only 4½ per cent.

Concerted Publicity

A naval approach to the publicising of transport facilities is being made by P. and O. Steam Navigation Company. 220 sub-contractors who are supplying products for the company's 45,000 ton passenger liner Canberra attended a conference at the Royal Festival Hall on 15 September "to develop their ideas for a concerted plan to publicise Canberra throughout the world." The ship, building at the Belfast yard of Harland and Wolff, is due to be launched early next year.

The delegates were welcomed by Sir Donald Anderson, deputy chairman of the P. and O. company, and listened to talks by Mr. J. West, leader of the design team on Canberra, and by Mr. J. W. Bunyan, engineering adviser to the company. After further talks by Prince Yurka Galitzine, public relations adviser, on editorial promotion and Mr. J. B. Stone, advertising manager, on cooperative advertising, a discussion took place from which plans for close co-ordination of publicity and advertising between those who are contributing to the building of Canberra were evolved. An electronic model of Canberra and photographs showing progress on the building of the vessel were on display.

Chicago and New York

A large gathering of American business men attended the World Marketing conference arranged by the Chicago Association of Commerce to coincide with the Chicago International Trade Fair and the opening of the St. Lawrence Seaway by the Queen. A British marketing executive, Mr. John H. Smeddle, of Landmaster Limited, addressed this conference on "New Markets for Imports to the USA."

Landmaster are members of the Firth Cleveland group of companies who have recently opened new offices in Canada and reorganised their associated companies in the United States. A new company has been formed in New York, Firth Cleveland Incorporated, with offices at 60 East 42nd Street. One of the new company's more important functions will be to distribute the steel strip roping wire, concrete reinforcement, sheet metal machine tools and hollow bored bars manufactured in England by Firth Cleveland Steel Strip, the Firth Company, Richard Hill and Keeton Sons and Company.

World Marketing Aids

Typically vigorous publicity is being carried out by J. J. Berliner and Staff, 684 Broadway, New York. Of the two major activities they carry out on a world wide basis, the best known is probably the Berliner's World Directories, sold as the best possible source of mailing lists and business information. Over 400 different directories are published, which the company say "have been painstakingly compiled to help you make profitable calls in all the markets of the world." They contain only essential information, that is, the names and addresses of firms in each classification, arranged alphabetically under each country "without extraneous data, or advertising matter." Most of the directories are priced at between $25 and $35.

Berliner's other services consist of what they call their "Continuous Catalogues Service" and their "Sample Buying Service." Under the former they will send subscribers up to 200 of the most recent issue of catalogues a year for a subscription of $105; under the latter the same number of samples, including copies of the patent covering the product, if required.

AEC in Jo'burg

Valuable but highly competitive export markets for heavy vehicles are inciting British manufacturers to increase their investment in sales and service facilities abroad. AEC Limited, a member of the Associated Commercial Vehicles group of companies, have recently formed a subsidiary in Johannesburg. The new company, AEC Vehicles (SA), works in conjunction with the South African firm, J. H. Plane (Africa). Their sales director, Mr. R. T. Knowles, is taking over his duties this month.

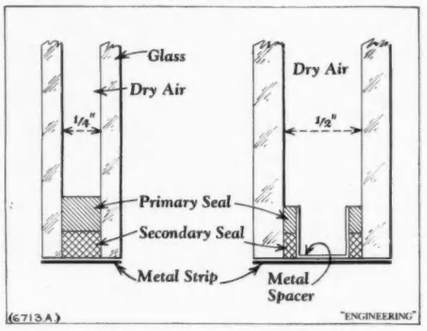
The value of the prizes which can be won abroad is shown by the latest order for buses obtained in Australia by Leyland: they are to supply 50 Royal Tiger Worldmaster single deck buses similar to the 156 ordered last year with fully automatic transmission. The customer in each case is the Department of Government Transport, New South Wales, and the total value of the order is some £1·3 million.

At Home

WINDOWS

Windows have been a mixed blessing to mankind ever since the first hole was made in a wall—probably to fire arrows through. Early glazing with horn must have cut off a lot of light but at least it did keep the wind out. Later glass was not much better.

Modern glass is certainly clear but it cuts out most of the ultra violet rays which can make a difference to health. Still it lets in both light and warmth and so fulfils its purpose; plate glass and float glass offer no distortion to vision. But glass has always one disadvantage which becomes the more noticeable the more there is of it—namely the heat loss that occurs. The heat transfer rate of glass is about 80 times that of a nine-inch brick wall, so it is not surprising that there are cold down draughts under window panes. It also means that fuel costs for room heating go up enormously when the window area is increased.



Multiglass units are sold without frames.

Fortunately there is a fairly simple remedy, one that has been common practice on the Continent for years but only rarely met even now in this country, possibly because winters here are by no means so severe as in central Europe and also because until the last decades coal was cheap, good and plentiful. The remedy is double glazing. Even the smallest air gap between two panes gives great results as dry still air has a heat transfer only one-seventh that of glass. Moreover condensation troubles are avoided and though children may no longer be able to draw on the panes they will always be able to look out. Apart from heat insulation, incoming noise is also greatly reduced.

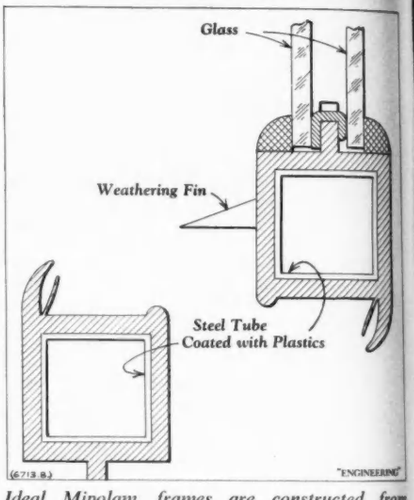
Double glazing is possible with almost all types of window, even existing sash frames can be converted with very little trouble. With rising fuel costs the initial cost of the extra glass and the work involved is probably still a saving in the long run, certainly for a new house it would be well worth while.

Double seal double glaze units without frames are made by Multiglass Limited. They are produced in a wide range of sizes up to about 60 ft super and 120 in long depending on the weight of glass incorporated. Thus 24 oz glass is only quoted up to 8 ft super with a maximum length of 48 in whereas double glazing units of $\frac{1}{4}$ in polished plate or drawn sheet go up to a maximum of 120 in by 72 in.

The lighter sizes are available with four different cavities, $\frac{1}{8}$ in, $\frac{3}{16}$ in, $\frac{1}{4}$ in, and $\frac{1}{2}$ in, the heavier only in $\frac{1}{4}$ in and $\frac{1}{2}$ in. The method of construction also varies slightly according to the thickness of the gap as may be seen from the illustration. Comparison figures are quoted for the heat transfer coefficients of these units for mild, average, and severe weather conditions. For the average, where single glazing would have a U value of 1·0, $\frac{1}{8}$ in cavity glass has 0·69; $\frac{3}{16}$ in has 0·61; $\frac{1}{4}$ in has 0·57 and $\frac{1}{2}$ in has 0·53. (U is measured in Btu per sq. ft per hr per °F temperature difference.)

These units are constructed with two seals; the internal one prevents the ingress of moisture vapour and the outer protects the inner from mechanical damage and is impervious to the oils used in putties and mastics. As a final safeguard an impervious metallic membrane is bonded round the edges of the units.

Double glazing is also available in units supplied complete with frames for use as windows or doors. Ideal Casements produce a range based on the construction shown in the second illustration. The basis is a hollow square section steel tube covered with a plastics extrusion. The grade of p.v.c. used is resilent and semiflexible and the shape includes a fixing fin which can be used either to locate the frame in the wall or, inverted, as the core for the double glazing. An edge fin is claw shaped and is used to seal the two parts when the window is closed.



Ideal Mipolam frames are constructed from plastics coated steel tube.

Between the two panes of glass, which fit on each side of the moulded fin, is an inverted mastic channel forming a seal and on top of that an inverted metallic channel. This last is drilled at intervals and contains some dessicant, usually phosphorous pentoxide, to maintain the air in the cavity quite dry. Outside each pane of glass is a plastics bead bonded in place with an adhesive. The corners of the beading are welded. Additional strength is given to the corners of the frame itself by a reinforcing angle inserted in the hollow tubes and fixed by epoxy resin.

ENGINEERING

Published every Friday by ENGINEERING LTD. at 36 Bedford Street, London, WC2.
elephone: Temple Bar 3663.
elegrams: Engineering Lesquare London.

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Annual subscription rates: Inland and abroad £5 10*s* (Canada, £5 5*s*). Three months 27*s* 6*d* all countries. Single copies, 2*s* 7*d* post free.

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